ADDENDUM 4-A

SURGE POND DESIGN PLAN

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907 Poplar Street, Suite 260
Casper, WY 82601

Ludeman ISR Uranium Project
Surge Pond Design

Prepared for Uranium One Americas
By TREC, Inc.

November 4, 2011

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APPENDICES

1.0 INTRODUCTION

Uranium One Americas is planning up to six (6) surge ponds to facilitate operations at its Ludeman In-Situ Recovery (ISR) Uranium Project. The project has three satellite plants. It is anticipated that two ponds will be installed at the first Satellite facility. The second and third Satellite facilities may only require one pond as the ponds at the other Ludeman Satellite facilities may be used for redundancy depending on flow conditions at the Ludeman Satellite plants at that time. The purpose of this report is to document the design of the ponds in order to amend the existing permit license (SUA-1341) to include surge ponds at the Ludeman Satellite plants.

Waste water will be generated during both the mining operation and the restoration phases. The primary means of disposing of this waste water will be via deep disposal wells. However, the deep disposal well(s) will not be operational when regular maintenance is being performed or when equipment is being replaced. Therefore, surge ponds have been designed as a back-up to the deep disposal well. The ponds are redundant in case one pond needs to be repaired or requires maintenance. The piping for each pond has been designed so that flow from either of the ponds can be directed to either the satellite plant for additional filtration, deep disposal well or another pond.

During operations, waste water generated at the satellite plant(s) will typically be pumped to a waste water tank, through a bag filter in the plant, and then to the disposal well building where the flow will pass through a cartridge filter before being injected into the deep disposal well. One waste water tank will be located in the plant to store water prior to transfer directly to the disposal well. The tank is fiberglass with a capacity of approximately 10,000 gallons.

When the deep disposal well is not available due to maintenance, annual testing, or otherwise, waste water will be pumped from the waste water tank to one of the surge ponds. When the deep disposal well is available again, the waste water in the surge pond will be pumped back to the plant and through bag filters prior to being pumped to the disposal well building. At the disposal well building, the waste water will again be filtered prior to injection in the disposal well.

2.0 POND DESIGN

The design of the surge ponds was conducted based on the NRC Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities", 10 CFR Part 40, Appendix A, Criterion 5(A). It

should be noted that these regulations apply to tailings impoundments. The surge ponds are a back-up system to the deep disposal well therefore some of the requirements for tailings ponds do not apply to the design of the surge ponds. The primary difference is the limited use of the surge ponds during the life of the facility. In addition, the surge ponds are considerably smaller than tailings impoundments and do not contain tailings.

2.1 DESIGN VOLUME DETERMINATION

The maximum waste water flow anticipated for a seven-day period is approximately 138,267 cubic feet of water (1,034,240 gallons). The seven day period is based on an existing operating plant which over its life has had a maximum deep disposal well shut down period for maintenance of one week. This volume is based on the maximum waste water flow that will occur when two well fields are both being restored (approximately 90 gpm). The maximum volume of waste water also includes 10 gpm to account for any waste water collected from well swabbing and also includes the volume of water contained in the curbing within the plant (30,346 gallons).

The conceptual layout of the facility and ponds is provided in Figures 1, 2 and 3 (Appendix A). The final operating volume of each surge pond is 199,100 cubic feet (1,489,270 gallons or 4.57 acre-feet) which includes 2.0 feet of freeboard. Each pond will be 140 feet by 245 feet (measured at the top, inside of the embankment) with a maximum depth of 8.0 feet (see Figure 2).

2.2 FREEBOARD ANALYSIS

NRC Guide 3.11 Basic Design Criteria item (e) requires that "freeboard must be sufficient at all times to prevent overtopping by flood inflows and wind generated waves and should include an allowance for settlement of the foundation and embankments." Calculations for the below factors are presented accordingly:

- Rainfall storage;
- Wave run up (with wind tide effects); and
- Settlement

The ponds are designed with raised berms such that "flood inflows" will not enter the surge ponds. Therefore, these ponds are only required to retain the precipitation that falls directly into the ponds. The NRC Guide 3.11 Basic Design Criteria requires using the 6-hour PMP. However, this design criteria is intended to address

impoundments for long term tailings retention (i.e. 1,000 year design storm). An alternative 6-hour/25 year design storm event is assumed on the basis of 1) the ponds are temporary for the life of the facility and will not be utilized for long term tailings impoundment; 2) The waste water will not contain mine tailings; 3) the surge ponds are provided as back up to deep disposal wells such that they are expected to be full for limited duration (i.e. one week max.); and 4) there are additional ponds for redundancy and extra capacity.

A 6-hour/25 year precipitation map from NOAA Atlas 2-Wyoming (Appendix B, Ref. 2) was used to determine the precipitation used for rainfall contribution to the pond volume. The rainfall volume is calculated based on the top of pond area multiplied by the rainfall depth as shown below:

6-hour/25 yr Precipitation = 2.4 inches
Top of Pond Area = 32,650 SF
Rainfall volume = 2.4 in. x 1 ft./12 in. x 32,650 SF = 6,530 CF

The rainfall storage volume of 6,530 cubic feet results in a storage depth of 0.1 feet (see Section 2.3 Pond Grading).

The NRC Guide 3.11 Basic Design Criteria suggests using procedures discussed in the U.S. Army Corps of Engineers (ACOE) "Coastal Engineering Manual" (Ref. 2) to determine wave run-up effects. Supplementary ACOE references are also used (Ref. 3 and 4). The first step in calculating wave run-up is to determine the design wave height. Figure 5-35 (Ref. 2) and the following assumptions were used to determine the design wave height:

- Wind speed of 80 mph based on ACOE Figure 5-18, 25-year wind occurrence (Appendix B, Ref. 2);
- Fetch length of 282 feet based on the longest top of pond dimension (e.g. diagonal span, see Figure 2); and
- Constant depth of five feet (actual design depth is 6.1' w/ rainfall storage, see Section 2.3 Pond Grading). Note that graphs are only available on five foot depth increments. Graph for constant depth of ten feet also results in 0.9 feet.

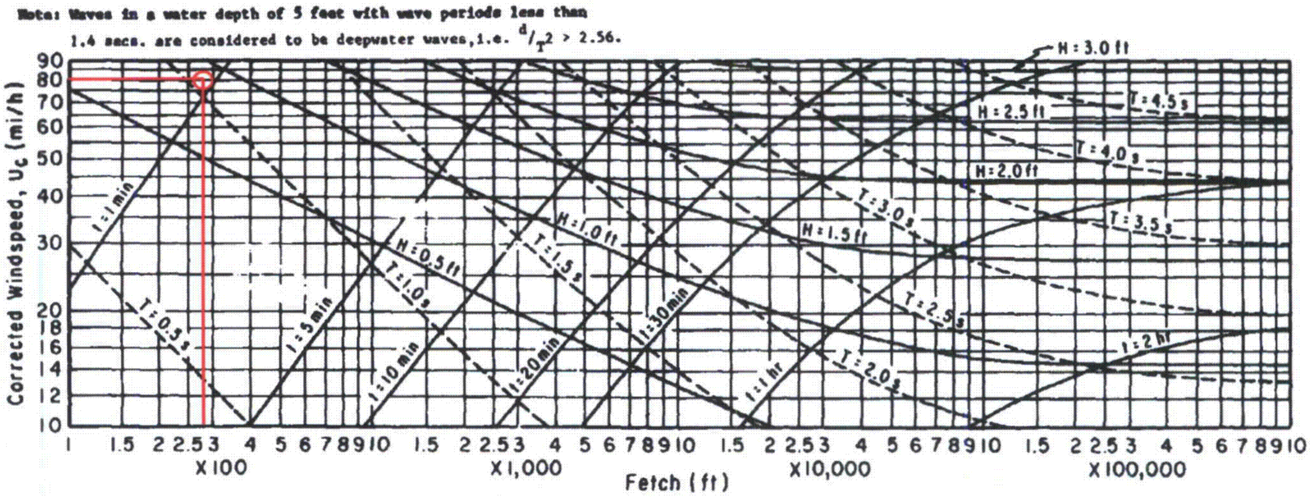


Figure 5-35. Forecasting curves for shallow-water waves (constant depth = 5 ft)

The design wave height (H, crest to trough) is determined to be 0.9 feet (conservative interpolation). Also determined from Figure-5-35 is the wave period (T) of 1.0 seconds. Both of these parameters are used in the subsequent wave run-up Figures 7-7 and 7-12 (Ref. 3) along with the assumptions the embankment has a smooth impermeable surface and is sloped at 3H:1V (Cot Θ = 3.0).

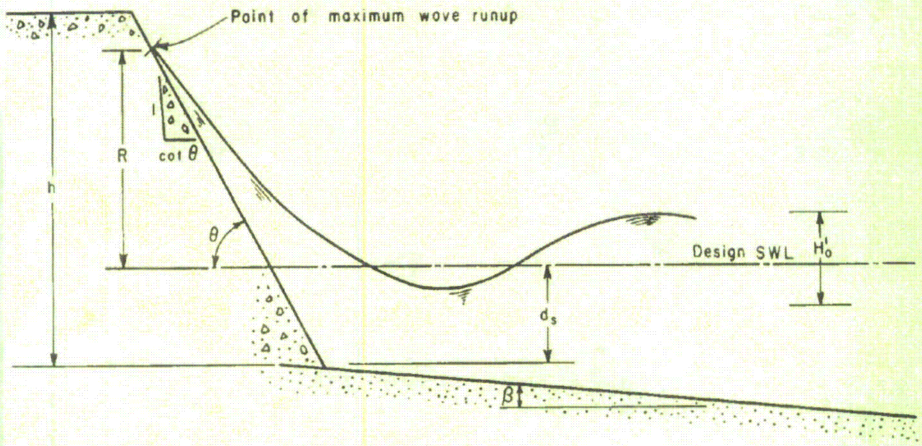


Figure 7-7. Definition sketch: wave runup and overtopping.

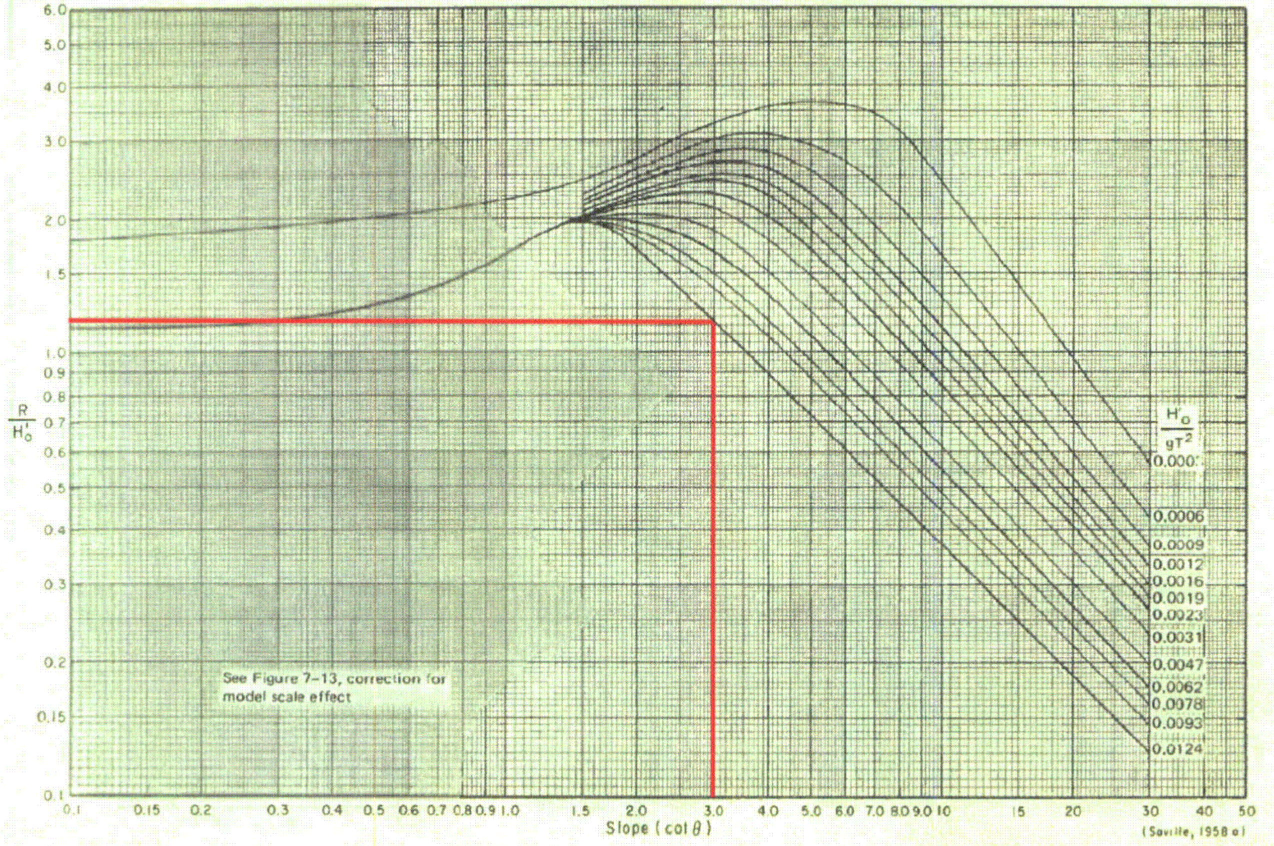


Figure 7-12. Wave runup on smooth, impermeable slopes when $d_s/H_o' \geq 3.0$.

It is noted that the equation H'_0/gT^2 results in a value of 0.028 that is off the chart such that the line for 0.0124 is conservatively used. Gravity (g) is assumed to be 32.2 ft/s and the wave period (T) is assumed to be 1.0 s (see previous paragraph). From Figure 7-12, the ratio of wave run-up (R) to wave height (H'_0, crest to trough) was determined to be 1.3, giving a wave run-up of 1.2 feet (0.9 ft x 1.3).

Wind tide is accounted for in addition to wave run-up. Wind tide (aka wind setup) explanation and associated Equation 3-1 is provided below (Ref. 2):

c. Simplified Prediction Methods.

(1) Storm surge in an enclosed basin. The tilting of the water surface is an enclosed basin (e.g., lakes and reservoirs) caused by wind shear stress is known as wind setup. The water surface is above the normal still-water level (SWL) on the leeward side of the basin and below the SWL on the windward side. Wind setup can be reasonably estimated for basins of simple shape and long compared to their width, assuming motion in the long axis only. Wind setup, the rise in the water level at the leeward end relative to the SWL, may be estimated by

$$S = \frac{U^2 F}{1400 d} \quad (3\text{-}1)$$

where

S = setup relative to the SWL (ft)

U = wind speed (mph)

F = fetch (miles)

d = average water depth over fetch (ft)

U is assumed to be 80 mph based on ACOE Figure 5-18, 25-year wind occurrence (Appendix B). F is assumed to be 0.093 miles (282 ft x 2 / 5280 ft/mile) based on ACOE guidance, "for practical purposes, it is usually satisfactory to assume that the wind tide fetch is equal to twice the effective fetch" (Ref. 4). The average water depth (d) is 6.1 feet based on required storage calculations w/ rainfall storage (see Section 2.3 Pond Grading). Equation 3-1 results in a wind tide of 0.1 feet.

Additional freeboard will be provided to account for settlement potential. The constructed berms will be thoroughly compacted such that settlement is expected to be minimal. For preliminary purposes, a minimum of 0.5 feet of additional freeboard is assumed to be adequate to account for settlement potential. Settlement will be further analyzed in the later design stage upon availability of site specific soil information and construction plans. Final construction planning will also ensure that NRC Guide 3.11 Basic Design Criteria item (c) is satisfied.

In summary, the required minimum freeboard is as follows:

Rainfall storage	0.1 feet
Wave run-up (w/ wind tide)	1.3 feet (1.2ft + 0.1ft)
Settlement	0.5 feet
Total Freeboard (min.) =	**1.9 feet**

2.3 POND GRADING

At present, site topographical information has not been obtained and a detailed pond design cannot be completed. Construction plans for the ponds will be prepared to reflect site specific design (i.e. topo, facility layout) for each of the three plant locations. The grading design will provide the required pond volume and free board. Final construction planning will also ensure that NRC Guide 3.11 Basic Design Criteria item (a) is satisfied. Figure 3 is provided as an example pond grading plan (Appendix A).

Based on the calculated required storage and freeboard, the ponds are proposed to be 245 feet in length and 140 feet in width at the top of embankment with a total depth of 8.0 feet (see Figure 2, Appendix A). Exterior embankment slopes are proposed to be graded at a maximum steepness of 2H:1V. Interior embankment slopes are proposed to be graded at a maximum steepness of 3H:1V. The required storage capacity of 138,267 CF results in a design storage depth of 6.0 feet and available freeboard depth of 2.0 feet. Table 1 summarizes how each of the required pond design parameters is accounted for with respect to both pond depth and pond storage.

Table 1: Pond Storage Summary

Pond Design Parameter	Pond Depth / Pond Storage
Disposal well and secondary cont. storage	6.0 feet / 138,267 cubic feet
Rainfall Storage of 0.1 feet	6.1 feet / 144,797 cubic feet
Wave run-up w/ wind tide = 1.3 feet	7.4 feet / 174,300 cubic feet
Settlement of 0.5 feet	7.9 feet / 189,800 cubic feet
Total provided =	8.0 feet / 199,100 cubic feet

2.4 SLOPE STABILITY ANALYSIS

Slope stability analyses involve comparing the shearing stresses along potential failure surfaces with the available shearing resistance along those surfaces. Neither a seismic stability analysis nor liquefaction will be analyzed as part of this design. Unlike tailings ponds, the surge ponds will have limited use and will be reclaimed as described in the project application. Additionally, the surge ponds are used as a secondary/backup system rather than a primary system. A Factor of Safety (FOS) is the ratio of the available shear strength to the developed maximum shear stress. In accordance with NRC Guide 3.11 a minimum FOS of 1.5 is required.

Slope stability for the Ludeman surge ponds was evaluated utilizing the computer program XSTABL. This program uses the "Method of Slices - Simplified Bishop Method" and allows the designer to evaluate various slope geometries, subsurface layering, different soil types, different failure modes, and loading conditions. The "Method of Slices - Simplified Bishop Method" is in accordance with NRC Guide 3.11 recommended methods of analyses. The ponds will utilize an impervious pond liner with a leak detection system in accordance with NRC Guide 3.11 Basic Design Criteria item (b). This requirement eliminates seepage conditions and is not factored in the slope stability analysis.

An outside slope of 2H:1V and an inside slope of 3H:1V are proposed for the pond slopes. The worst case stability scenario expected would be the pond being full (including freeboard) with an embankment height of 8.0 feet and top width of 15 feet. The final pond design will likely be such that the ponds will be partially embedded (i.e. exterior embankment height < 8.0 feet), thus the analysis provided is considered conservative. Detailed soil information for the three sites is currently unavailable. For the purpose of providing preliminary calculations, the below values were used and are expected to be conservative compared to actual field conditions. Prior to final design and construction, detailed soil information will be collected to confirm that site soil properties exceed the parameters used in this preliminary analysis.

- Soil Density – 124 pounds per cubic foot;
- Soil Cohesion – 150 pounds per square foot;
- Friction Angle – 14 degrees; and
- Water Density – 62.4 pounds per cubic foot

The slope stability analyses results are included in Appendix C. The output files list the boundary coordinates, soil parameters, water surface parameters, restrictions, and resulting FOS of 2.065, exceeding the required minimum of 1.5.

2.5 SLOPE PROTECTION

Slope protection will be applied to both the interior and exterior slopes of the surge ponds. The interior slopes of the ponds will be protected from destructive wave action by a double liner system further described below. A perimeter fence with controlled access, for maintenance purposes, will be installed around the perimeter of the pond to prevent animals from gaining access to the ponds and potentially damaging the liner.

The exterior slopes of the pond embankment will be covered with topsoil which will be tracked with a dozer to provide horizontal divots to minimize erosion. The slopes will then be seeded.

3.0 LINER SYSTEMS AND LEAK DETECTION

The liner system designed for the project consists of a 30 mil poly vinyl chloride (PVC) bottom liner and a 36 mil Reinforced Polypropylene (RPP) top liner with a geotechnical fabric in-between to allow any moisture to flow to the leak detection system. The RPP liner is stable under exposure to ultraviolet radiation. RPP also has good chemical resistance and high puncture resistance.

It is anticipated that the liquid waste stream at the Ludeman facility will be chemically and radiologically similar to the waste disposed in disposal wells in operation at existing ISR operations in the Powder River Basin. The anticipated chemical composition of the waste stream water during operations is provided in Table 2. During restoration, the waste water stream will consist of a brine solution from the reverse osmosis units. It is estimated that the maximum flow of liquid wastes at the Ludeman facility will be approximately 30 gallons per minute (gpm) during normal operations and an approximately 100 gpm (90 gpm from the wellfields and 10 gpm from well swabbing) during the restoration phase.

A leak detection system has been designed to identify the approximate location of leaks so repairs can be made to the liner system and in order to isolate leaks so that they can be controlled. The pond subgrade will be graded to allow this permeable layer to drain to sumps where any leaks can be monitored. See Figure 2 (Appendix A) for details of the leak detection system.

Table 2: Summary of Anticipated Waste Stream Water Quality

	Estimated Range of Waste Stream Water Quality	
Chemical Species	Minimum	Maximum
pH (std. units)	6	9
Sodium (mg/l)	150	3,000
Calcium (mg/l)	200	1,000
Potassium (mg/l)	10	1,000
Bicarbonate as HCO3 (mg/l)	1,500	4,000
Carbonate as CO3 (mg/l)	0	500
Sulfate (mg/l)	80	2,000
Chloride (mg/l)	200	4,000
Uranium as U3O8 (mg/l)	1	15
Ra-226 (pCi/l)	300	3,000
TDS (mg/l)	4,000	15,000

4.0 REFERENCES

1. Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems at Uranium Recovery Facilities," U.S. Nuclear Regulatory Commission, Washington, DC, November 2008.
2. Engineer Manual 1110-2-1414, "Water Levels and Wave Heights for Coastal Engineering", U.S. Army Corps of Engineers Service, Washington, DC, July 1989.
3. Shore Protection Manual, Vol.II U.S. Army Corps of Engineers Service, Vicksburg, Mississippi – 1984
4. Engineer Manual 1110-2-1420, "Hydrologic Engineering Requirements for Reservoirs", U.S. Army Corps of Engineers Service, Washington, DC, October 1997.
5. NOAA Atlas 2, "Precipitation, Frequency Atlas of the Western United States – Volume II-Wyoming", J.F. Miller, R.H. Frederick, and R.J. Tracey, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Silver Spring, Maryland – 1973.

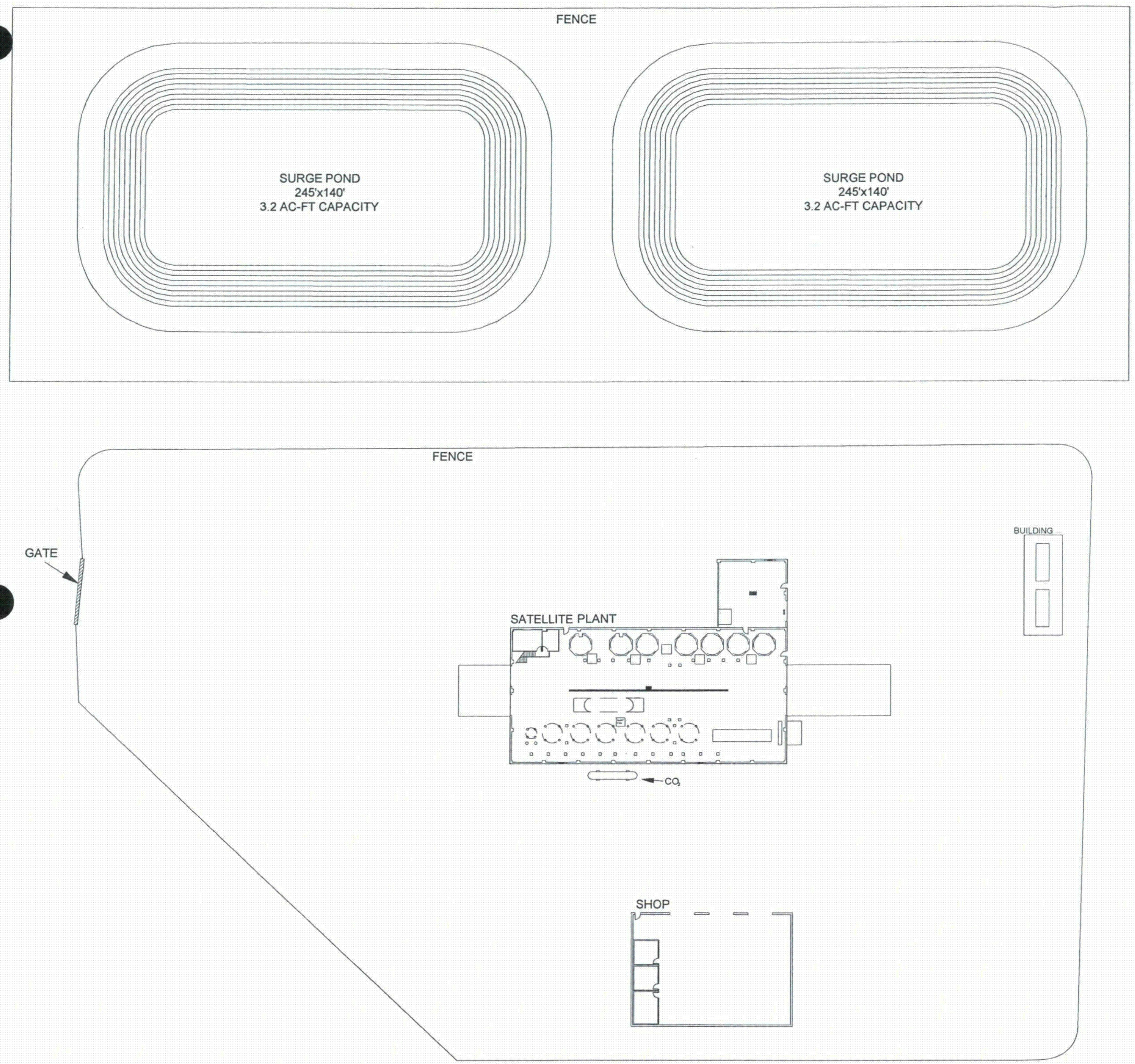
APPENDICES

Appendix A: Facility and Pond Design Figures

Appendix B: Reference Documentation

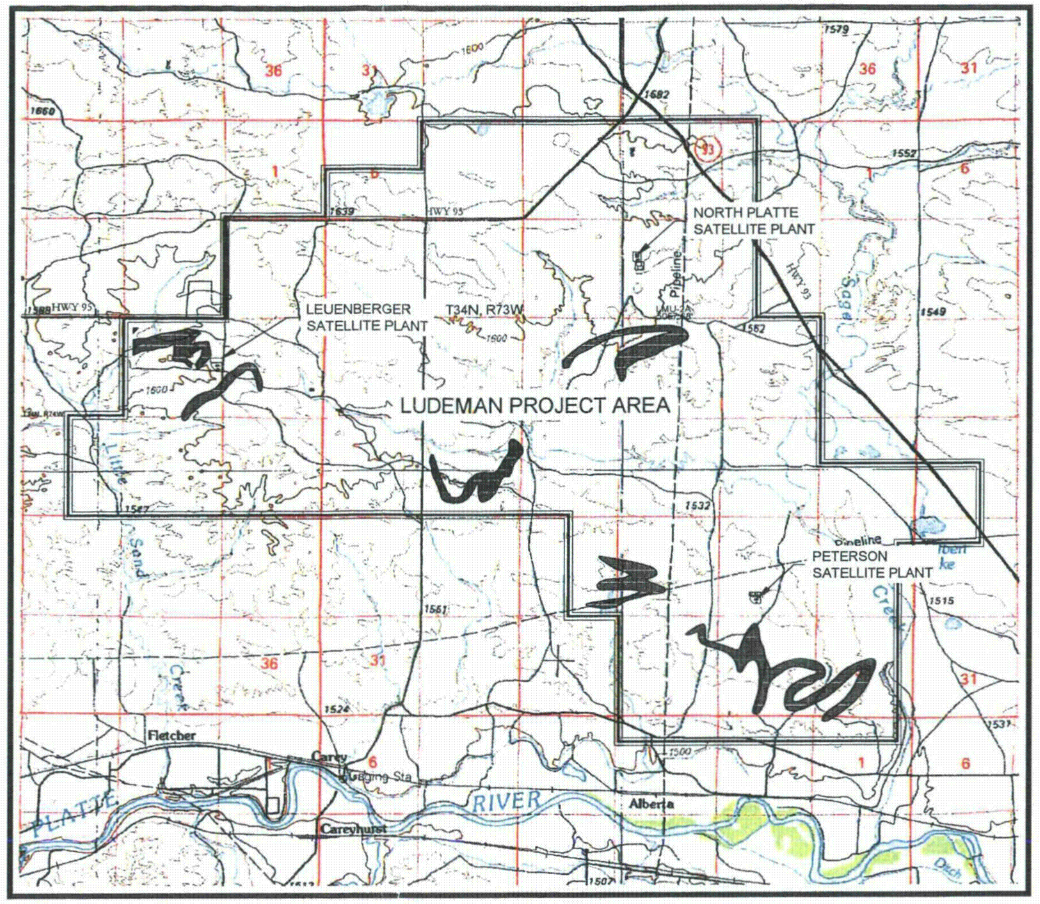
Appendix C: Slope Stability Analysis

Appendix A: Facility and Pond Design Figures



TYPICAL SITE LAYOUT

1" = 40'



SITE LOCATION MAP

1" = 1 MILE

SURGE PONDS - TWO REQUIRED
TOP AREA EACH POND = 0.75 ac
TOTAL DEPTH = 8.0'
OPERATING LEVEL DEPTH = 6.0'
FREEBOARD = 2.0'
TOTAL VOLUME EACH POND = 4.57 ac-ft
OPERATING VOLUME EACH POND = 3.17 ac-ft

DAM/PERMIT APPLICATION IS NOT REQUIRED SINCE POND VOLUME IS <15 ac-ft
SPILLWAY IS NOT REQUIRED SINCE ALL RUNOFF IS DIVERTED AWAY FROM PONDS
CALCULATIONS COMPLETED WITH CARLSON - POND/PIT VOLUME
LEAK MONITORING WILL BE PERFORMED AT REGULARLY SCHEDULED INTERVALS
LEAK LOCATION SURVEYS WILL BE CONDUCTED WHEN LEAKS ARE DETECTED

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Ludeman Satellite Project

Facility Layout and Locations

Date: 11/04/11	By: MAM	Checked:	Approved:
Rev. No.	Description	Date	By

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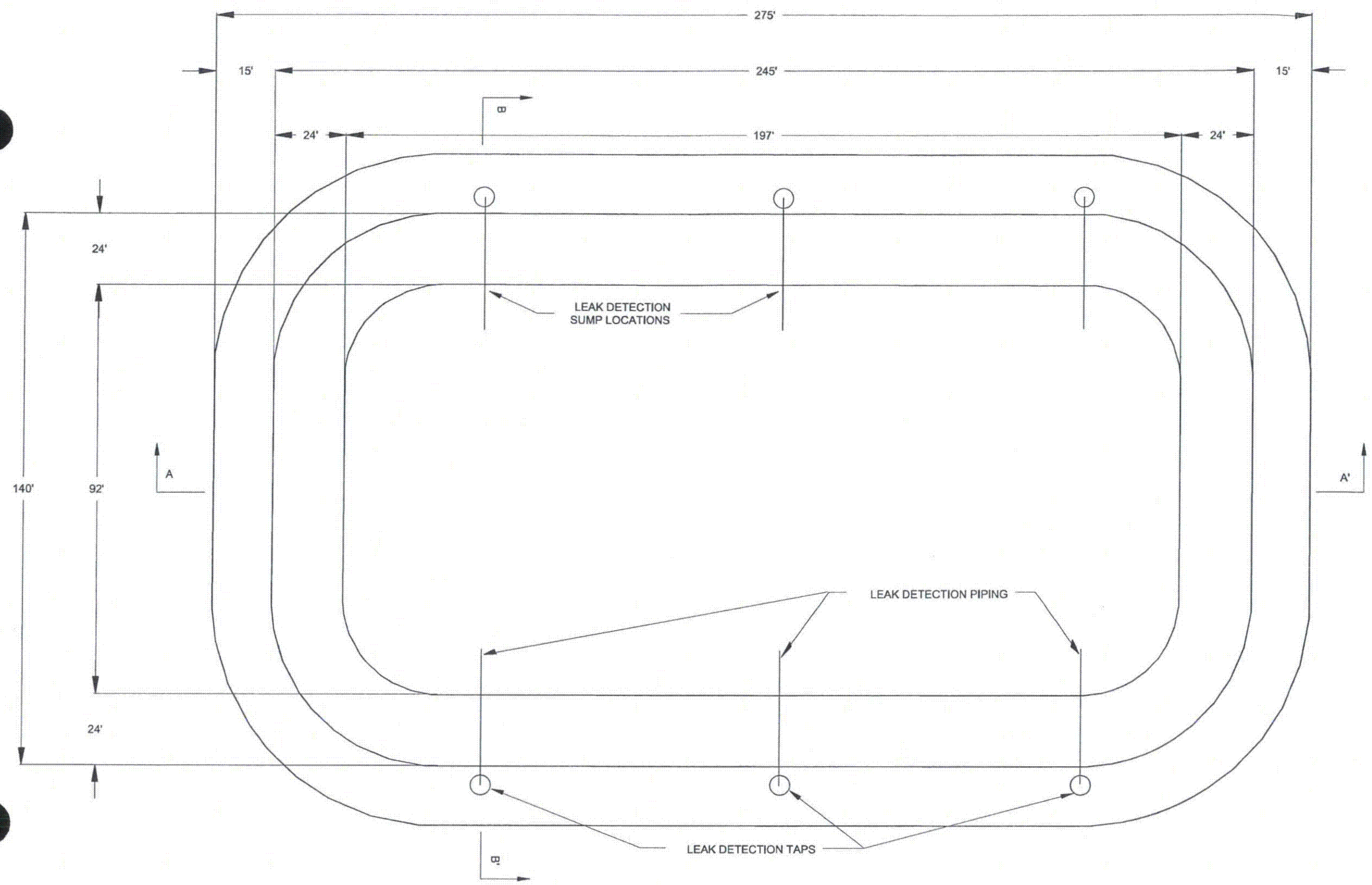
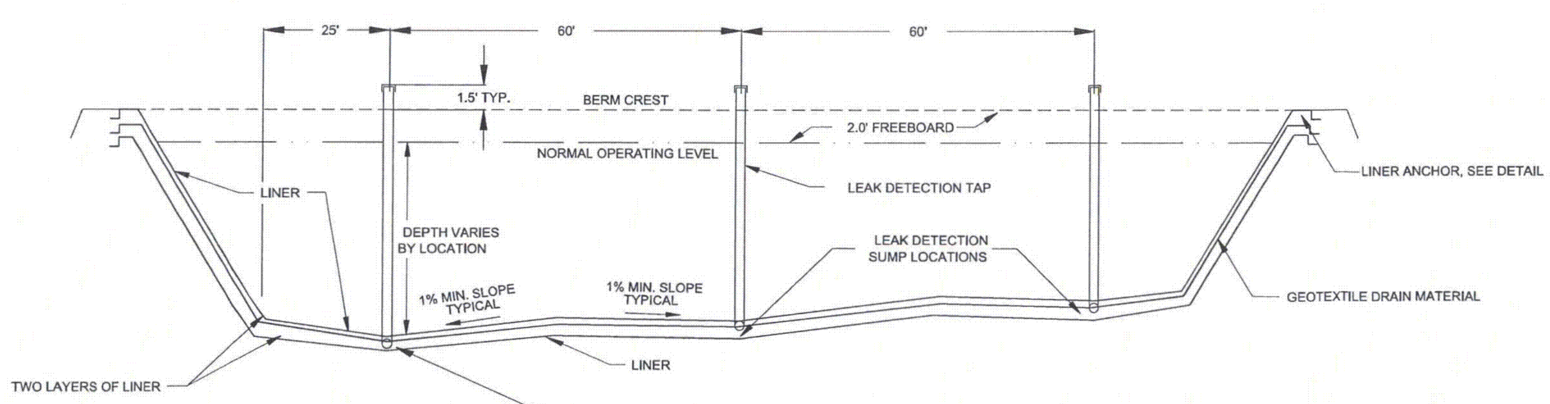
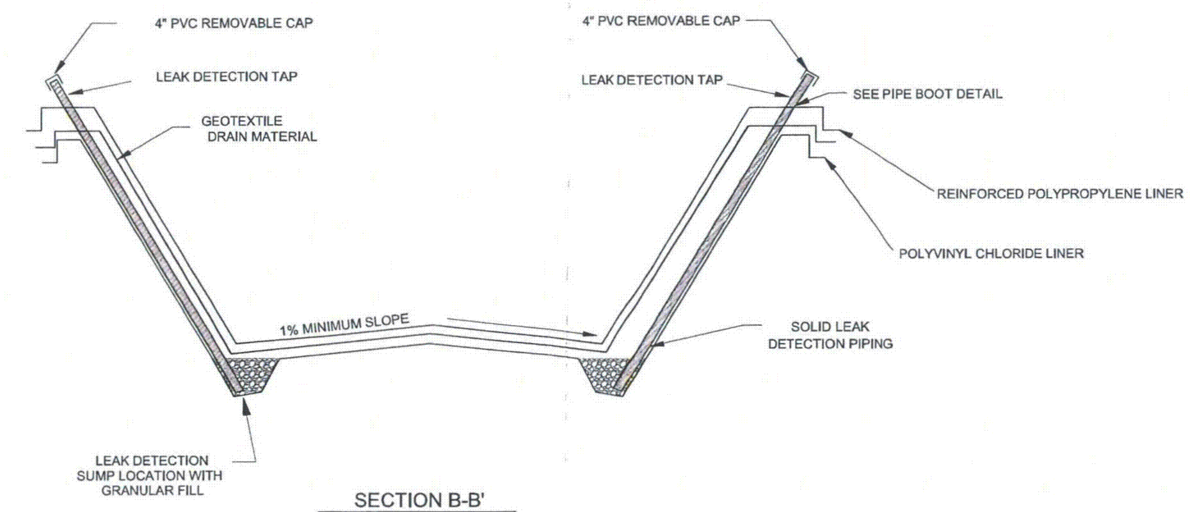
Sheet:
FIGURE 1



PLAN VIEW
NTS



SECTION A-A'
NTS



SECTION B-B'
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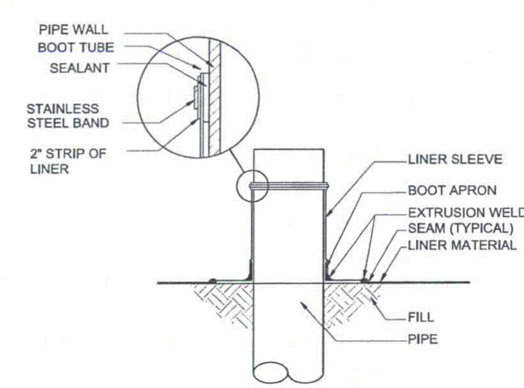
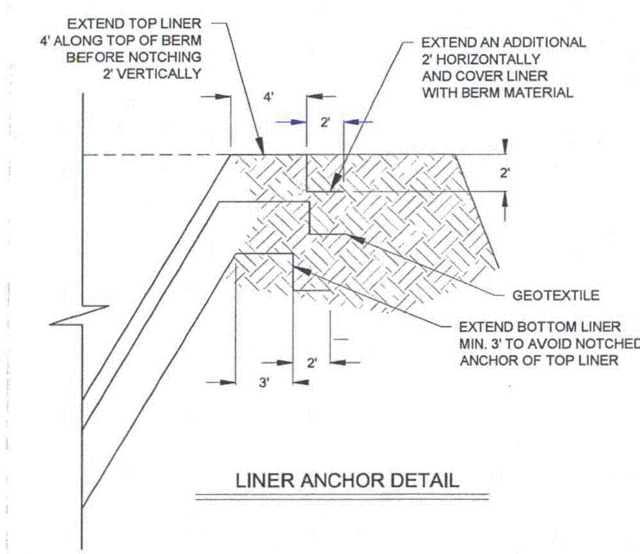


PIPE BOOT DETAIL



LINER ANCHOR DETAIL

SURGE PONDS - TWO REQUIRED
TOP AREA EACH POND = 0.75 ac
TOTAL DEPTH = 8.0'
OPERATING LEVEL DEPTH = 6.0'
FREEBOARD = 2.0'
TOTAL VOLUME EACH POND = 4.57 ac-ft
OPERATING VOLUME EACH POND = 3.17 ac-ft

DAM/PERMIT APPLICATION IS NOT REQUIRED SINCE POND VOLUME IS <15 ac-ft
SPILLWAY IS NOT REQUIRED SINCE ALL RUNOFF IS DIVERTED AWAY FROM PONDS
CALCULATIONS COMPLETED WITH CARLSON - POND/PIT VOLUME
LEAK MONITORING WILL BE PERFORMED AT REGULARLY SCHEDULED INTERVALS
LEAK LOCATION SURVEYS WILL BE CONDUCTED WHEN LEAKS ARE DETECTED

NOTES:

1. LEAK DETECTION TAP - 4" DIA SCH 40 PVC PIPE
2. LEAK DETECTION TAPS USED AS WATER RETRIEVAL POINTS

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Ludeman Satellite Project
Preliminary Surge Pond Design

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Rev. No.	Description	Date	By

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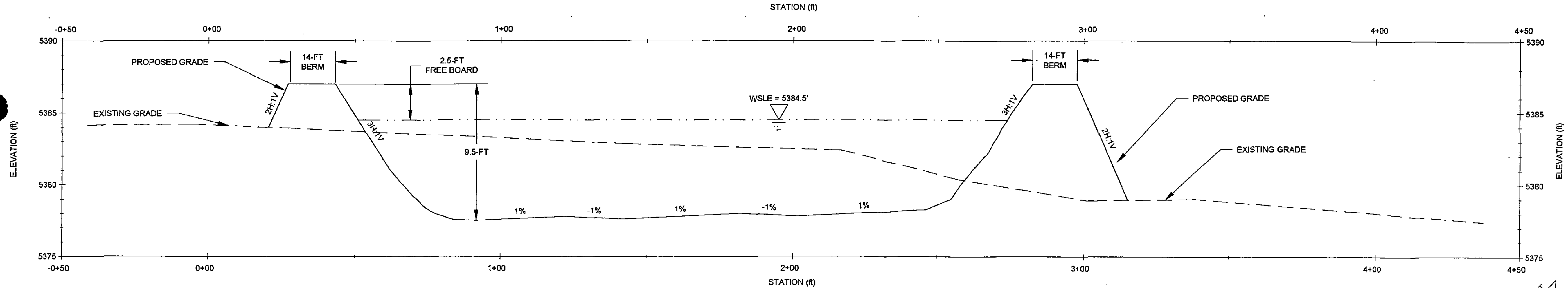
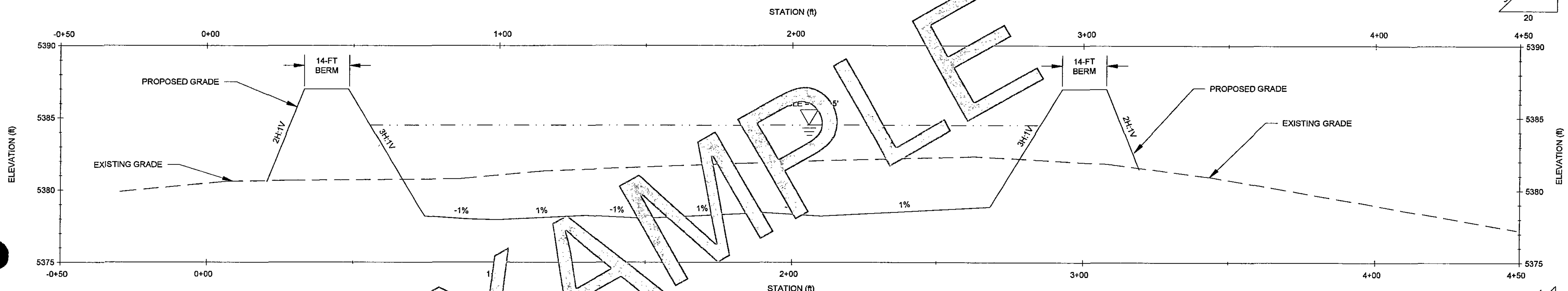
Engineering & Environmental Management

Sheet:
FIGURE 2



SURGE POND SECTION - AA



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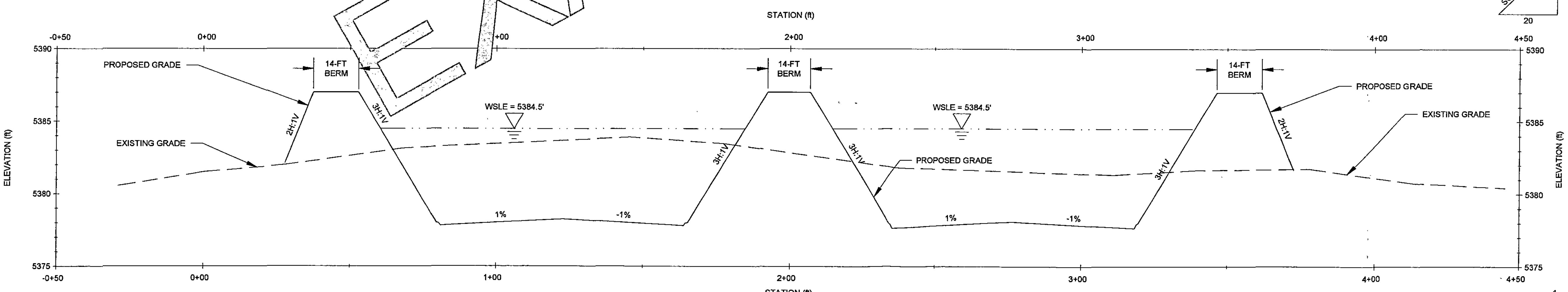

SURGE POND SECTION - CC

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EXAMPLE Pond Grading

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FIGURE 3

Appendix C Slope Stability Analysis

XSTABL File: M1 10-27-11 14:26

```
****************************************
*              X S T A B L             *
*                                      *
*       Slope Stability Analysis       *
*              using the               *
*           Method of Slices           *
*                                      *
*        Copyright (C) 1992 - 99       *
*   Interactive Software Designs, Inc. *
*        Moscow, ID 83843, U.S.A.      *
*                                      *
*          All Rights Reserved         *
*                                      *
*  Ver. 5.203             96 - 1999    *
****************************************
```

Problem Description :

SEGMENT BOUNDARY COORDINATES

4 SURFACE boundary segments

Segment No.	x-left (ft)	y-left (ft)	x-right (ft)	y-right (ft)	Soil Unit Below Segment
1	.0	.0	16.0	8.0	1
2	16.0	8.0	31.0	8.0	1
3	31.0	8.0	55.0	.0	1
4	55.0	.0	80.0	.0	1

ISOTROPIC Soil Parameters

1 Soil unit(s) specified

Soil Unit Weight Cohesion Friction Pore

```
Pressure      Water
          Unit  Moist    Sat.   Intercept   Angle  Parameter
Constant  Surface
           No.  (pcf)   (pcf)    (psf)      (deg)      Ru
(psf)      No.

             1   124.0   124.0    150.0     14.00      .000
.0      0
```

1 Water surface(s) have been specified

Unit weight of water = 62.40 (pcf)

Water Surface No. 1 specified by 2 coordinate points

```
**********************************
        PHREATIC SURFACE,
**********************************
```

Point No.	x-water (ft)	y-water (ft)
1	31.00	8.00
2	80.00	8.00

-- WARNING

Water surface number 1 has been defined but is not used by any soil unit. The analysis will IGNORE water surface # 1. Please make sure that this assumption is consistent with your subsurface model.

A critical failure surface searching method, using a random technique for generating CIRCULAR surfaces has been specified.

100 trial surfaces will be generated and analyzed.

10 Surfaces initiate from each of 10 points equally spaced along the ground surface between x = .0 ft

and x = 16.0 ft

Each surface terminates between x = 16.0 ft
and x = 31.0 ft

Unless further limitations were imposed, the minimum elevation
at which a surface extends is y = .0 ft

* * * * * DEFAULT SEGMENT LENGTH SELECTED BY XSTABL * * * * *

1.0 ft line segments define each trial failure surface.

ANGULAR RESTRICTIONS

The first segment of each failure surface will be inclined
within the angular range defined by :

Lower angular limit := -45.0 degrees
Upper angular limit := (slope angle - 5.0) degrees

****
-- WARNING -- WARNING -- WARNING -- WARNING -- (# 48)

****
Negative effective stresses were calculated at the base of a slice.
This warning is usually reported for cases where slices have low self
weight and a relatively high "c" shear strength parameter. In such
cases, this effect can only be eliminated by reducing the "c" value.

****
****

```
          -----------------------------------------------------------
-----
          USER SELECTED option to maintain strength greater than
zero
          -----------------------------------------------------------
-----
```

****

```
          **     Factor of safety calculation for surface #    81
**
          **     failed to converge within FIFTY iterations
**
          **
**
          **    The last calculated value of the FOS was  25.1560
**
          **    This will be ignored for final summary of results
**
```

****

```
      Circular surface (FOS= 25.1560) is defined by: xcenter =
13.41
      ycenter =     11.68   Init. Pt. =     14.22   Seg. Length =
1.00
      -----------------------------------------------------------
--------
```

****

```
          **     Factor of safety calculation for surface #    83
**
          **     failed to converge within FIFTY iterations
**
          **
**
          **    The last calculated value of the FOS was  36.4404
**
          **    This will be ignored for final summary of results
**
```

****

Circular surface (FOS= 36.4404) is defined by: xcenter =
20.75
ycenter = 15.72 Init. Pt. = 14.22 Seg. Length =
1.00

****
** Factor of safety calculation for surface # 84
**
** failed to converge within FIFTY iterations
**
**
**
** The last calculated value of the FOS was 31.0926
**
** This will be ignored for final summary of results
**

****

Circular surface (FOS= 31.0926) is defined by: xcenter =
19.66
ycenter = 11.84 Init. Pt. = 14.22 Seg. Length =
1.00

****
** Factor of safety calculation for surface # 85
**
** failed to converge within FIFTY iterations
**
**
**
** The last calculated value of the FOS was 21.1746
**
** This will be ignored for final summary of results
**

****

Circular surface (FOS= 21.1746) is defined by: xcenter =
16.33
ycenter = 19.06 Init. Pt. = 14.22 Seg. Length =
1.00

```
          ------------------------------------------------------------
--------


*************************************************************
          **     Factor of safety calculation for surface #    86
**
          **     failed to converge within FIFTY iterations
**
          **
**
          **    The last calculated value of the FOS was  41.6130
**
          **    This will be ignored for final summary of results
**

*************************************************************


      Circular surface (FOS= 41.6130) is defined by: xcenter =
21.42
      ycenter =     14.01   Init. Pt. =     14.22   Seg. Length =
1.00
      ------------------------------------------------------------
--------


*************************************************************
          **     Factor of safety calculation for surface #    87
**
          **     failed to converge within FIFTY iterations
**
          **
**
          **    The last calculated value of the FOS was  23.2189
**
          **    This will be ignored for final summary of results
**

*************************************************************


      Circular surface (FOS= 23.2189) is defined by: xcenter =
18.27
      ycenter =     10.59   Init. Pt. =     14.22   Seg. Length =
1.00
      ------------------------------------------------------------
--------
```

```
***********************************************************
         **     Factor of safety calculation for surface #    89
**
         **     failed to converge within FIFTY iterations
**
         **
**
         **    The last calculated value of the FOS was  29.3998
**
         **    This will be ignored for final summary of results
**

***********************************************************


     Circular surface (FOS= 29.3998) is defined by: xcenter =
12.54
     ycenter =     13.77   Init. Pt. =     14.22   Seg. Length =
1.00
     -----------------------------------------------------------
--------


***********************************************************
         **     Factor of safety calculation for surface #    90
**
         **     failed to converge within FIFTY iterations
**
         **
**
         **    The last calculated value of the FOS was  33.7672
**
         **    This will be ignored for final summary of results
**

***********************************************************


     Circular surface (FOS= 33.7672) is defined by: xcenter =
20.26
     ycenter =     13.75   Init. Pt. =     14.22   Seg. Length =
1.00
     -----------------------------------------------------------
--------


***********************************************************
         **     Factor of safety calculation for surface #    91
**
```

```
          **     failed to converge within FIFTY iterations
**
          **
**
          **    The last calculated value of the FOS was*********
**
          **    This will be ignored for final summary of results
**

*************************************************************

      Circular surface (FOS=********) is defined by: xcenter =
17.38
      ycenter =      8.68   Init. Pt. =     16.00   Seg. Length =
1.00
      -------------------------------------------------------------
--------


*************************************************************
          **     Factor of safety calculation for surface #    92
**
          **     failed to converge within FIFTY iterations
**
          **
**
          **    The last calculated value of the FOS was*********
**
          **    This will be ignored for final summary of results
**

*************************************************************

      Circular surface (FOS=********) is defined by: xcenter =
16.98
      ycenter =      9.62   Init. Pt. =     16.00   Seg. Length =
1.00
      -------------------------------------------------------------
--------


*************************************************************
          **     Factor of safety calculation for surface #    93
**
          **     failed to converge within FIFTY iterations
**
          **
**
```

```
          **    The last calculated value of the FOS was*********
**
          **    This will be ignored for final summary of results
**

************************************************************


      Circular surface (FOS=********) is defined by: xcenter =
18.24
      ycenter =     10.45   Init. Pt. =     16.00   Seg. Length =
1.00
      ------------------------------------------------------------
--------



************************************************************
          **     Factor of safety calculation for surface #    94
**
          **     failed to converge within FIFTY iterations
**
          **
**
          **    The last calculated value of the FOS was*********
**
          **    This will be ignored for final summary of results
**

************************************************************


      Circular surface (FOS=********) is defined by: xcenter =
23.42
      ycenter =     15.82   Init. Pt. =     16.00   Seg. Length =
1.00
      ------------------------------------------------------------
--------



************************************************************
          **     Factor of safety calculation for surface #    95
**
          **     failed to converge within FIFTY iterations
**
          **
**
          **    The last calculated value of the FOS was*********
**
          **    This will be ignored for final summary of results
**
```

```
************************************************************

      Circular surface (FOS=********) is defined by: xcenter =
18.10
      ycenter =     12.27   Init. Pt. =     16.00   Seg. Length =
1.00
      -----------------------------------------------------------
--------


************************************************************
          **     Factor of safety calculation for surface #    96
**
          **      failed to converge within FIFTY iterations
**
          **
**
          **    The last calculated value of the FOS was*********
**
          **    This will be ignored for final summary of results
**

************************************************************

      Circular surface (FOS=********) is defined by: xcenter =
18.38
      ycenter =     13.59   Init. Pt. =     16.00   Seg. Length =
1.00
      -----------------------------------------------------------
--------


************************************************************
          **     Factor of safety calculation for surface #    97
**
          **      failed to converge within FIFTY iterations
**
          **
**
          **    The last calculated value of the FOS was*********
**
          **    This will be ignored for final summary of results
**

************************************************************
```

```
    Circular surface (FOS=********) is defined by: xcenter =
17.49
    ycenter =      9.65   Init. Pt. =     16.00   Seg. Length =
1.00
    ------------------------------------------------------------
--------


************************************************************
          **     Factor of safety calculation for surface #    98
**
          **     failed to converge within FIFTY iterations
**
          **
**
          **    The last calculated value of the FOS was*********
**
          **    This will be ignored for final summary of results
**
************************************************************

    Circular surface (FOS=********) is defined by: xcenter =
17.36
    ycenter =     10.20   Init. Pt. =     16.00   Seg. Length =
1.00
    ------------------------------------------------------------
--------


************************************************************
          **     Factor of safety calculation for surface #    99
**
          **     failed to converge within FIFTY iterations
**
          **
**
          **    The last calculated value of the FOS was*********
**
          **    This will be ignored for final summary of results
**
************************************************************

    Circular surface (FOS=********) is defined by: xcenter =
17.62
    ycenter =      8.96   Init. Pt. =     16.00   Seg. Length =
1.00
```

```
      ---------------------------------------------------------------
--------

*************************************************************
          **     Factor of safety calculation for surface #   100
**
          **     failed to converge within FIFTY iterations
**
          **
**
          **    The last calculated value of the FOS was*********
**
          **    This will be ignored for final summary of results
**
*************************************************************

      Circular surface (FOS=********) is defined by: xcenter =
16.56
      ycenter =       8.59   Init. Pt. =      16.00   Seg. Length =
1.00
      ---------------------------------------------------------------
--------


          Factors of safety have been calculated by the :

          * * * * *   SIMPLIFIED BISHOP METHOD   * * * * *


            The most critical circular failure surface
            is specified by 23 coordinate points

                 Point        x-surf        y-surf
                  No.          (ft)          (ft)

                   1           1.78           .89
                   2           2.76           .71
                   3           3.76           .59
                   4           4.75           .52
                   5           5.75           .51
                   6           6.75           .55
                   7           7.75           .64
                   8           8.74           .78
                   9           9.72           .98
                  10          10.69          1.23
                  11          11.64          1.53
```

12	12.58	1.88
13	13.49	2.28
14	14.39	2.73
15	15.26	3.22
16	16.10	3.77
17	16.91	4.35
18	17.69	4.98
19	18.43	5.65
20	19.14	6.35
21	19.80	7.10
22	20.43	7.88
23	20.52	8.00

**** Simplified BISHOP FOS = 2.065 ****

```
*****************************************************************
***
          **
**
          ** Out of the    100 surfaces generated and analyzed
by XSTABL, **
          **       18 surfaces were found to have MISLEADING FOS
values.   **
          **
**

*****************************************************************
***
```

The following is a summary of the TEN most critical surfaces

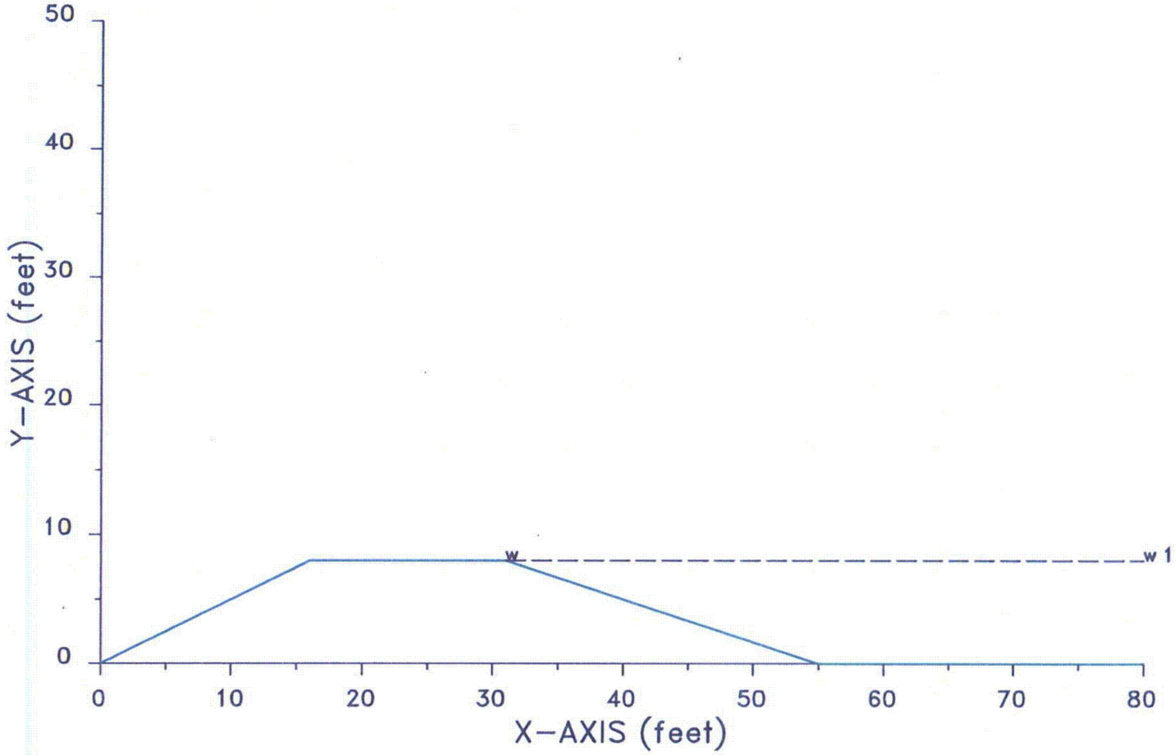
Problem Description :

	FOS (BISHOP)	Circle Center x-coord (ft)	Circle Center y-coord (ft)	Radius (ft)	Initial x-coord (ft)	Terminal x-coord (ft)	Resisting Moment (ft-lb)
1.	2.065	5.54	19.25	18.74	1.78	20.52	9.066E+04
2.	2.156	4.26	18.79	18.07	1.78		

```
18.75   7.425E+04
             3.   2.167        6.54     24.58     24.16      1.78
24.11   1.449E+05
             4.   2.188        6.97     24.93     24.59      1.78
24.81   1.547E+05
             5.   2.206        9.43     12.03     11.82      3.56
20.52   6.141E+04
             6.   2.228        3.71     19.03     18.25      1.78
18.24   7.085E+04
             7.   2.249        7.70     10.88     10.00      3.56
17.27   3.770E+04
             8.   2.280        8.79      9.01      8.93      3.56
17.65   3.994E+04
             9.   2.313        4.02     32.93     32.12      1.78
24.27   1.788E+05
            10.   2.395       -3.83     54.85     54.98       .00
24.94   3.214E+05
```

* * * END OF FILE * * *

M1 10-27-11 14:26



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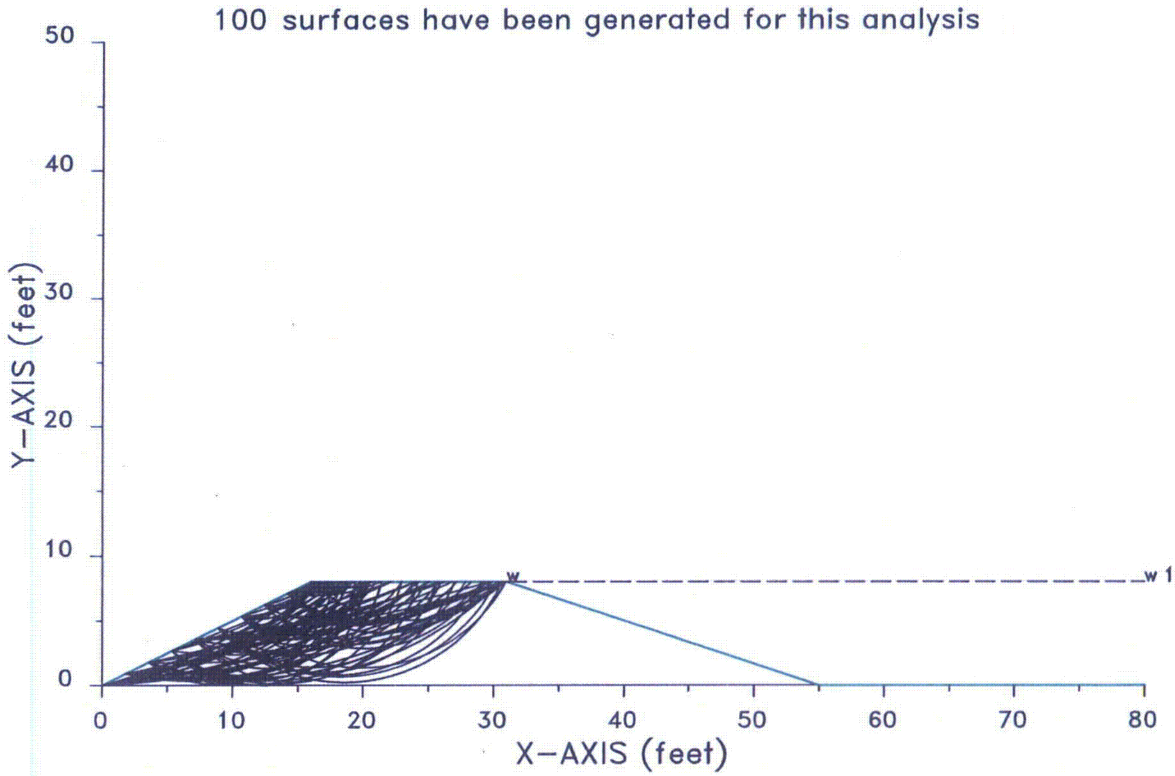
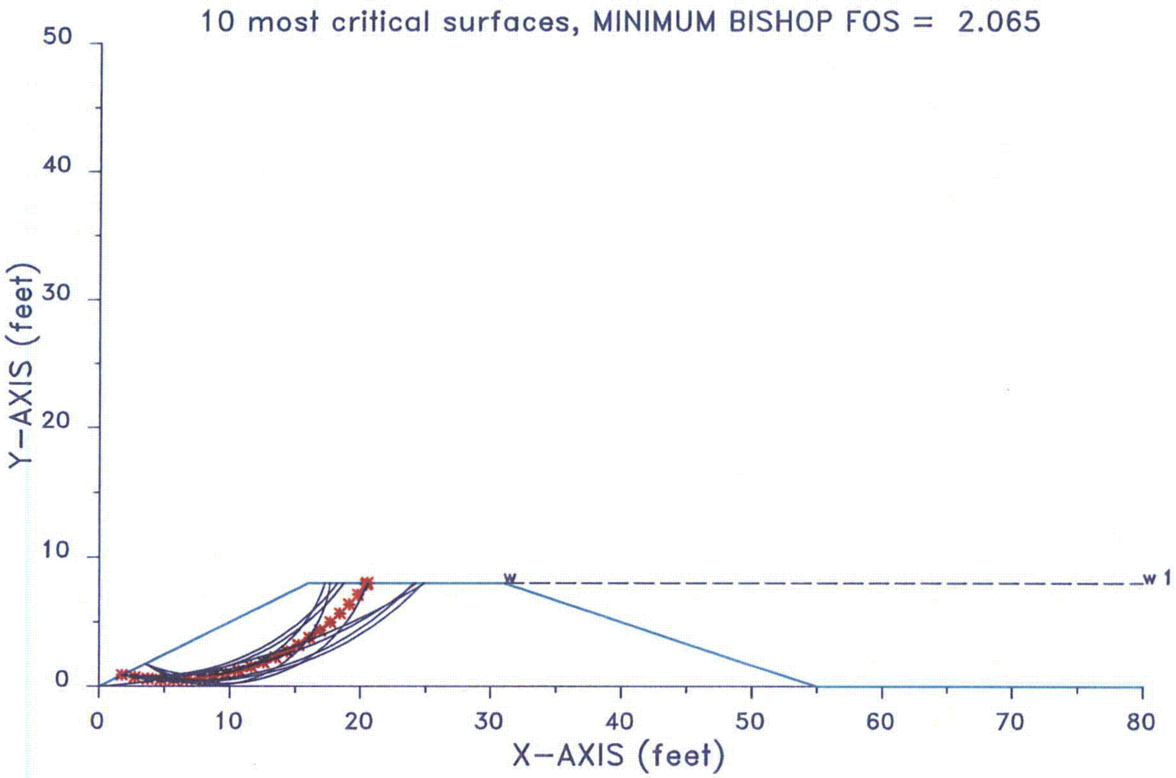


M1 10-27-11 14:26



Sample Slope Stability Numbers

Table 3.

Worksheet for slope stability and seismic deformation analyses

Material Description	Density γ (pcf)	Cohesion c (psf)	Angle of Internal Friction ϕ	Reference Source
Vegetative Cover (Cohesive)	102	1200-1600	25-45	[26], [27]
Final Cover Clay Liner	92 - 96	1400 - 2800	14 - 24	[28]
Interim Cover (Cohesive)	90 -102	50 - 2800	14 - 20	[29], [26], [27]
Solid Waste (Municipal)	30 - 65	50 - 2000	1 - 37	[30], [31]
Municipal Baled	32 - 47	50 - 2000	1 - 37	[30], [31], [32]
Geosynthetic Drainage Composite (GDL)		40 - 60	19.6 – 26	[33], [34], [35]
Geomembrane (Textured) (Cover)		40 - 60	15 – 32*	[33], [34], [36]
(Primary Liner)	75 - 80	20 – 520	7 – 35*	[28], [33], [34], [36]
Geomembrane (Smooth) (Cover)		-	6 – 9*	[33], [34], [35]
(Primary Liner)		-	4 – 6*	[33], [34], [35]
Geosynthetic Clay Liner (GCL)				
Granular Layer	110 - 124	0 - 800	26 - 40	[26], [28], [29]
Primary Clay Liner	92 - 96	1400 - 2800	14 - 24	[26], [28]
Foundation Soil Clay	90 - 100	1000 - 3000	14 - 24	[26], [28]
Silt (Soft to Medium)	100	0 - 1500	15 - 20+	[27], [37]
Sands and Gravels (Loose to Dense)	90 - 140	0 - 800	25 - 48	[26], [28], [29], [37]
Rip Rap / Rock Fill	145	-	30 - 50	[29]
Bedrock (Impenetrable)	NA	NA	NA	[38]
* values indicate interface contact with non-woven geotextile				

---

[26] Spangler, M.G. & Handy, R.L., Soil Engineering, 3rd Edition, Intext International, 1973, pp. 559, Table 22-1
[27] Seelye, E.E., Design-Data Book for Civil Engineers, 3rd Edition, J. Wiley, 1968, pp 9-08, Tables G & H
[28] Abramson, L. W. & Lee, T.S. et al., Slope Stability and Stabilization Methods, 2nd Edition, J Wiley, 2002, pp. 42. Table 1.8
[29] Huang, Y.H., Stability Analysis in Earth Slopes, Van Nostrand Reinhold, 1983, pp. 35-36, Table 3-1 & 3-2
[30] Sharma, H.D. & Lewis, S. P., Waste Containment Systems, Waste Stabilization, and Landfills: Design and Evaluation, 1st Edition, J. Wiley, 1994, pp. 65-66 & Figure 2.15
[31] Abramson, L.W., Slope Stability and Stabilization Methods, 2nd Edition, J. Wiley, 2002, pp 678-679, Table 10.2; Figure 10.9; pp. 687-688, Table 10.9
[32] Montague, D.J. and Baker, J.T., 1998, Baling Out Small Landfills, Waste Age Magazine, April 1, 1998
[33] GSE Technical Note – Direct Shear & Friction Angle Testing for GSE Geomembranes (TN018 R11/04/02, www.gseworld.com)
[34] Sharma, H.D. & Lewis, S. P., Waste Containment Systems, Waste Stabilization, and Landfills: Design and Evaluation, 1st Edition, J. Wiley, 1994, pp. 147 - 149 & Tables 3.13 – 3.15
[35] Fox, P.J. and Stark, T.D., State-of-the-art report: GCL shear strength and its measurement, Geosynthetics International, 2004, Vol. 11, No. 3, pp. 141 - 175
[35] Stark, T.D., et al., M ASCE, HDPE Geomembrane / Geotextile Interface Shear Strength, Journal of Geotechnical Engineering, March 1996, pp 197 - 203
[37] Merritt, F.S. et al., Standard Handbook for Civil Engineers, Fourth Edition, McGraw Hill, 1996, pp 7-27 Table 7.7 and pp 7.81 Table 7.15
[38] Krahn J., Stability Modeling with SlopeW, An Engineering Methodology, First Edition, May 2004, Geo-Slope International, Ltd., Calgary, Alberta, Canada, www.geoslope.com, pp 141

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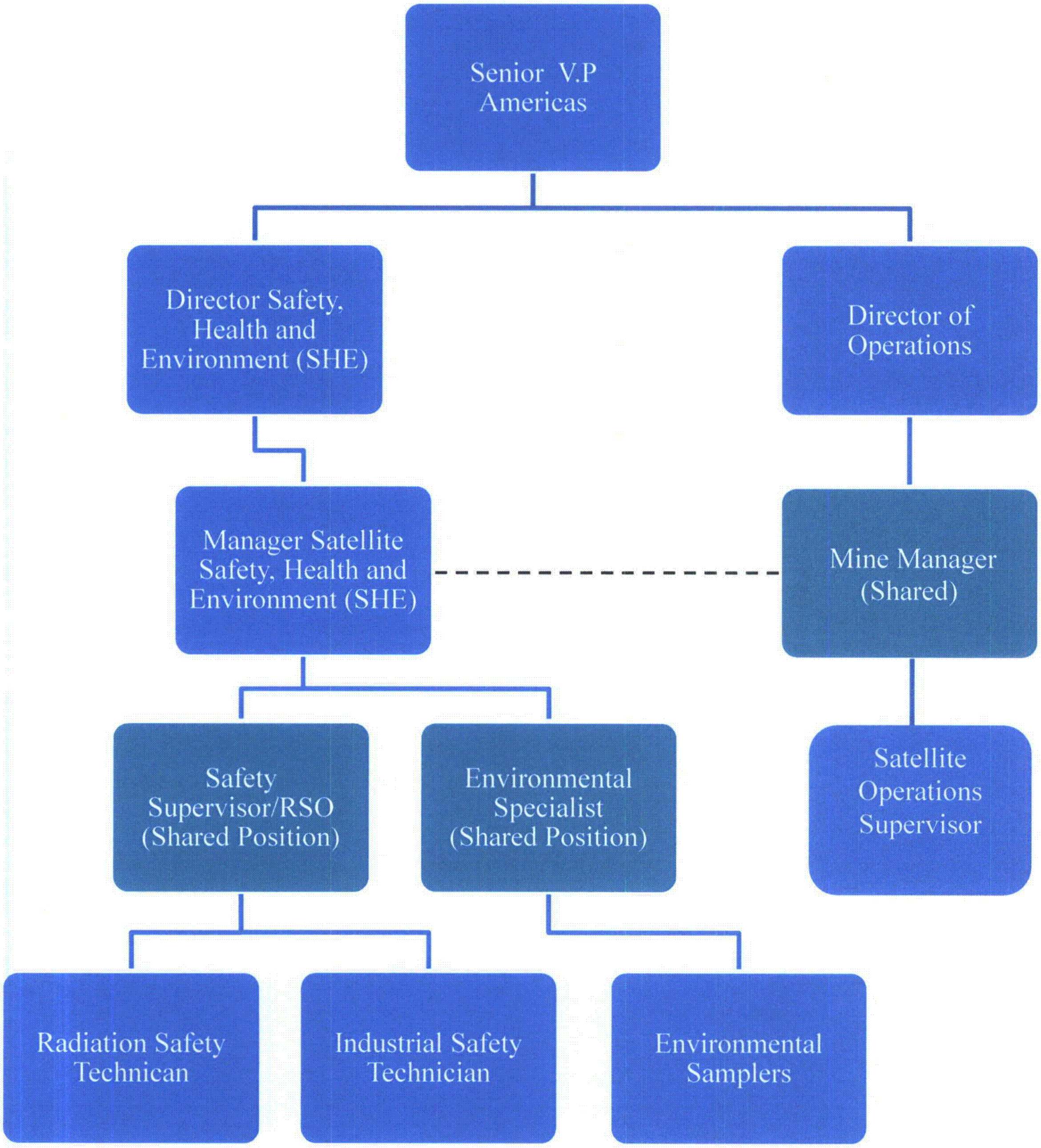
5 OPERATIONS

Uranium One is committed to conducting all operations in conformance with applicable laws, regulations and requirements of the NRC and other regulatory agencies. The responsibilities described below have been designed to ensure compliance and further implement Uranium One's policy for providing a safe working environment with cost effective incorporation of the philosophy of maintaining radiation exposures as low as is reasonably achievable (ALARA).

5.1 CORPORATE ORGANIZATION AND ADMINISTRATIVE PROCEDURES

Uranium One will maintain a performance-based approach to the management of the environment and employee health and safety, including radiation safety. Figure 5-1 is a partial organization chart for Uranium One with respect to the operation of the proposed Ludeman Project (proposed project) and associated operations and represents the management levels that play a key part in the Radiation Protection Program (RPP). The personnel identified are responsible for the development, review, approval, implementation, and adherence to operating procedures, programs, environmental and groundwater monitoring programs as well as routine and non-routine maintenance activities. The individuals in the positions identified in the Figure 5-1, may also serve a functional part of the Safety and Environmental Review Panel (SERP) described in Section 5.2.4.

Figure 5-1 Uranium One USA. Inc. Oraganizational Chart



5.1.1 Senior Vice President, Americas

The Senior Vice President, Americas (SVP) is responsible for management of all company projects and operations in the U.S. In this role, the SVP has the responsibility and authority for the radiation safety and environmental compliance programs at these operations. The SVP is responsible for ensuring that Uranium One personnel comply with industrial safety, radiation safety, and environmental protection programs as established in the Uranium One program. The SVP is also responsible for compliance with all regulatory license conditions/stipulations, regulations and reporting requirements. The SVP has the responsibility and authority to terminate immediately any activity that is determined to be a threat to employees or public health, the environment, or potentially a violation of state or federal regulations.

5.1.2 Director of Operations

The Director of Operations has overall responsibility for the America's ISR mining operations including those at Willow Creek. The Director Operations has the responsibility and the authority to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The Director of Operations cannot unilaterally override a decision for suspension, postponement or modification if that decision is made by the Manager Satellite SHE or the Safety Supervisor/RSO. The Director of Operations reports directly to the Senior Vice President, Americas. The Mine Manager reports directly to the Director of Operations.

5.1.3 Mine Manager

The Mine Manager is directly responsible for all uranium production activities at the Uranium One facilities. The Mite Manager is authorized to immediately implement any action to correct or prevent hazards. The Mine Manager has the responsibility, duty, and the authority to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The Mine Manager cannot unilaterally override a decision for suspension, postponement or modification of the operation if that decision is made by the Manager Satellite SHE or the Safety Supervisor/RSO. The Mite Manager reports directly to the Director of Operations.

5.1.4 Director of Safety, Health, and Environment (SHE)

The Director of SHE is responsible at the corporate Americas level for developing and managing the safety, health and environmental programs, policies, standards and

practices at all uranium production and exploration projects in the United States. This includes ensuring that operations comply with applicable safety, health, and environmental regulations and permits, including those under the authority of the WDEQ and USNRC. The Manager Site SHE reports directly to the Director of SHE. The Director of SHE reports directly to the Senior Vice President, Americas.

5.1.5 Manager of Satellite Safety, Health, and Environment (SHE)

The Manager of Satellite SHE is responsible for the development and implementation of all safety, health, and environmental programs at the Uranium One Satellite operations. This includes the compliance with, and maintenance of, all operational licenses and permits including the radiation protection requirements of the NRC. This individual also assists and guides the Radiation Safety Officer (RSO), if and when necessary, with associated routine and special responsibilities. The Manager Site SHE has oversight for the development, review, approval, implementation and adherence to radiation safety programs, environmental and groundwater monitoring programs and associated quality assurance programs. The Manager Site SHE has both the responsibility and authority to suspend, postpone or modify any work activity that is unsafe or potentially in violation of USNRC's regulations or license conditions, including the ALARA program. The Manager Satellite SHE reports to the Director of SHE and has a secondary reporting function to the Mine Manager. The Safety Supervisor/RSO and the Environmental Specialist report directly to the Manager Satellite SHE.

5.1.6 Satellite Operations Supervisor

The Satellite Operations Manager is responsible for all uranium production activity at the proposed Ludeman Project site. All site operations, maintenance, construction, and support groups report directly to the Satellite Operations Supervisor and environmental health and safety have coordinating reporting responsibilities as shown in Figure 5-1. In addition to production activities, the Satellite Operations Manager is also responsible for implementing any industrial and radiation safety and environmental protection programs associated with proposed Ludeman operations. The Satellite Operations Manager is authorized to immediately implement any action to correct or prevent hazards. The Satellite Operations Manager has the responsibility and the authority to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The Satellite Operations Manager cannot unilaterally override a decision for suspension, postponement or modification if that decision is made by the RSO. The Satellite Operations Manager reports directly to the Mine Manager.

5.1.7 Safety Supervisor/Radiation Safety Officer

The Safety Supervisor/Radiation Safety Officer (RSO) has direct responsibility for the development, review, approval, implementation and adherence to the Industrial Safety and Radiation Safety Programs and associated quality assurance programs for the Willow Creek operation. The Safety Supervisor / RSO is responsible for the collection and interpretation of all safety monitoring data, and the proper recording and reporting of such. The Safety Supervisor / RSO conduct routine training programs for the supervisors and employees with regard to the proper application of radiation protection and industrial safety procedures. This individual is also responsible for the implementation of, and adherence to, all regulatory license and reporting requirements. The Safety Supervisor/RSO, with assistance from the Radiation Safety Technician(s) (RST's), or other qualified designee(s), personally inspects facilities to verify compliance with all applicable health physics and radiation safety requirements. The Safety Supervisor/RSO has both the responsibility and authority to suspend, postpone or modify any work activity that is unsafe or potentially a violation of USNRC's regulations or license conditions, including the ALARA program. The Safety Supervisor/RSO, with assistance from the Industrial Safety Technician(s), or other qualified designee(s), personally inspects operations to verify compliance with all applicable OSHA industrial safety requirements. The Safety Supervisor/RSO reports directly to the Manager Site SHE. The Radiation Safety Technicians(s) and Industrial Safety Technicians(s) report directly to the Safety Supervisor/RSO.

5.1.8 Radiation Safety Technician

One or more Radiation Safety Technicians (RST) will assist the RSO with the implementation of the radiological and industrial safety programs. The RST is responsible for the orderly collection and interpretation of all monitoring data, to include data from radiological safety and environmental programs. RSTs will also be responsible for implementing and verifying that sampling and monitoring data is collected and evaluated in compliance with appropriate and defined QA/quality control (QC) Standard Operating Procedures (SOPs). The RST reports directly to the RSO.

5.1.9 ALARA Program Responsibilities

The purpose of the ALARA Program is to keep exposures to all radioactive materials and other hazardous material as low as possible and to as few personnel as possible, taking into account the state of technology and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of atomic energy in the public interest.

In order for an ALARA Program to correctly function, all individuals including management, supervisors, health physics staff, and workers, must take part in, and share responsibility for, keeping all exposures as low as reasonably achievable. This policy addresses this need and describes the responsibilities of each level in the organization.

5.1.9.1 Management Responsibilities within the ALARA Program

Consistent with Regulatory Guide 8.31 (USNRC, 2002), Uranium One senior management is responsible for the development, implementation, and enforcement of applicable rules, policies, and procedures as directed by regulatory agencies and company policies. These responsibilities include the following:

1. The development of a strong commitment to and continuing support of the implementation and operations of the ALARA program;
2. An Annual Audit Program which reviews radiation monitoring results, procedural, and operational methods;
3. A continuing evaluation of the RPP including adequate staffing and support;
4. Proper training and discussions that address the ALARA Program and its function to all facility employees and, when appropriate, to contractors and visitors; and
5. Providing information and policy statements to employees, contractors, and visitors.

5.1.9.1.1 Radiation Safety Officer Responsibilities within the ALARA Program

The RSO is responsible for ensuring the technical adequacy of the radiation protection program, implementation of proper radiation protection measures, and the overall surveillance and maintenance of the ALARA Program. The RSO is assigned the following:

1. The responsibility for the development and administration of the ALARA Program;
2. Enforcement of regulations and administrative policies that affect the RPP;
3. Assist with the review and approval of new equipment, process changes or operating procedures to ensure that the plans do not adversely affect the RPP;
4. Maintain equipment and surveillance programs to assure continued implementation of the ALARA Program;
5. Assist with conducting an Annual ALARA Audit as discussed in Section 5.3.2 to determine the effectiveness of the program and make any appropriate recommendations or changes as may be dictated by the ALARA philosophy;
6. Annually review all existing operating procedures involving or potentially involving any handling, processing, or storing of radioactive materials to ensure

the procedures are ALARA and do not violate any newly established or instituted radiation protection practices; and

7. Conduct daily inspections of pertinent facility areas to observe that general radiation control practices, hygiene, and housekeeping practices are in line with the ALARA principle.

5.1.9.1.2 Supervisor Responsibility within the ALARA Program

Supervisors have front line responsibility for implementing all safety programs including the ALARA program. Each supervisor will be trained and instructed in the general radiation safety practices and procedures. Their responsibilities include:

1. Adequate training to implement the general philosophy behind the ALARA Program;
2. Provide direction and guidance to subordinates in ways to adhere to the ALARA Program;
3. Enforcement of rules and policies as directed by the Radiological Protection Program, which implement the requirements of regulatory agencies and company management; and
4. Seek additional help from management and the RSO should radiological problems be deemed by the supervisor to be outside their sphere of training.

5.1.9.1.3 Worker Responsibility within the ALARA Program

Because success of both the Radiation Protection and ALARA Programs are contingent upon the cooperation and adherence to those policies by the workers themselves, the facility employees must be responsible for certain aspects of the program in order for the program to accomplish its goal of keeping exposures as low as reasonably achievable. Worker responsibilities include:

1. Adherence to all rules, notices, and operating procedures as established by management and the RSO through the Radiological Protection Program;
2. Making valid suggestions which might improve the radiation protection and ALARA programs;
3. Reporting promptly, to immediate supervisor, any malfunction of equipment or violation of procedures which could result in an increased radiological hazard;
4. Proper use of protective equipment; and
5. Proper performance of required contamination surveys when leaving restricted areas.

5.1.10 Reporting Procedures

Reporting of excursions and corrective actions will be conducted as described in Section 5.7.8.

The WDEQ-LQD will be verbally notified (per telephone or email) within 24 hours of discovery of a spill of ISR process fluids exceeding 420 gallons. A written report will be provided to the WDEQ-LQD within five days of discovery containing the information described in WDEQ-LQD Rules and Regulations, Chapter 11, Section 12(a)(B)(ii).

The NRC will be verbally notified (per telephone or email) within 48 hours of discovery of a spill that must be reported to the WDEQ (i.e., spill of ISR process fluids exceeding 420 gallons). A written report will be provided to the NRC within 30 days of discovery containing the information required per NRC License Conditions.

Other unanticipated spills of reportable quantities from chemicals bulk storage areas will be reported to the WDEQ in accordance with WDEQ-WQD, Rules and Regulations, Chapter 17, Part E and 40 CFR 302 (CERCLA).

Other operational reporting and applicable requirements include the following:

- Corrective Actions and Compliance Schedules- WDEQ-LQD Rules and Regulations, Section 13 and NRC License Conditions;
- Quarterly Monitoring Reports- WDEQ-LQD Rules and Regulations, Section 15;
- Annual Operations Reports- WDEQ-LQD Rules and Regulations, Section 15;
- Well Abandonment Reports- WDEQ-LQD Rules and Regulations, Section 15;
- Deep Disposal Well Monitoring Reports- Done in accordance with UIC injection well permit issued by the WDEQ-WQD; and
- NRC Semi-Annual Report- Done in accordance with 10 CFR §40.65 and NRC License Conditions.

5.2 MANAGEMENT CONTROL PROGRAM

5.2.1 Operating Procedures

Written Standard Operating Procedures (SOPs) have been developed under SUA-1341 for operations at the Willow Creek Project. In many cases, the same procedures can be applied to operations at the proposed Ludeman Project. In particular, radiation protection, environmental monitoring, and industrial safety procedures should be applicable to operations at all three sites. Where site- specific procedures are required at the proposed

Ludeman Project, Uranium One will develop procedures consistent with the corporate policies and standards and regulatory requirements. In particular, site-specific procedures will likely be necessary for certain process operations and emergency response. Operating procedures at the proposed Ludeman Project will be implemented as described in Section 5.2.1 of the License Renewal Application (LRA) for SUA-1341.

5.2.2 Radiation Work Permits

Radiation Work Permits (RWPs) will be implemented at the proposed Ludeman Project to control non-routine work or maintenance activities where the potential for radiation exposure exists and for which written operating procedures have not been prepared. RWPs at the proposed Ludeman Project will be implemented as described in Section 5.2.1 of the LRA for SUA-1341.

5.2.3 Record Keeping and Retention

The RSO will be responsible for ensuring that the required records are maintained and controlled. Records will be maintained as hard copy originals or stored electronically in accordance with the requirements of 10 CFR 20 Subpart L and 10 CFR 40.61 (d) and (e). Records will be readily available for regulatory inspection and may be transferred to the NRC after license termination. Records will also be provided to a new owner or new licensee in the event that the property or license is transferred. The new licensee or owner will be required to demonstrate that such records received from Uranium One will be retained or turned over to the NRC after license termination.

The following specific records will be permanently maintained and retained until license termination:

- Records of disposal of byproduct material on site through the deep disposal wells as required in 10 CFR §20.2002 and transfers or disposal off site of source or byproduct material;
- Records of surveys, calibrations, personnel monitoring, and bioassays as required in 10 CFR §20.2103;
- Records of information related to site and aquifer characterization and background radiation levels;
- As-built drawings and photographs of structures, equipment, restricted areas, well fields, areas where radioactive materials are stored, and any modifications showing the locations of these structures and systems; and
- Records of the radiation protection program including program revisions, standard operating procedures, radiation work permits, training and qualification records, SERP proceedings, and audits.

- Records containing information pertinent to decommissioning and reclamation including:
  - Descriptions of any spills, excursions, contamination events or unusual occurrences, including the dates, locations, areas, or facilities affected; assessments of hazards; corrective and cleanup actions taken; assessment of cleanup effectiveness, and the location of any remaining contamination; nuclides involved; quantities, forms and concentrations, and descriptions of hazardous constituents; descriptions of inaccessible areas that cannot be cleaned up; and sketches, diagrams, or drawings marked to show areas of contamination and places where measurements were made;
  - Information related to site characterization such as: residual soil contamination levels, on-site locations used for burials of radioactive materials, hydrology and geology characteristics that could contribute to contamination and locations of surface impoundments and wellfield aquifer anomalies.;
  - As-built drawings or photographs of structures, equipment, restricted and secured areas, wellfields, areas where radioactive materials are stored, and any modifications showing the locations of these structures and systems through time;
  - Drawings of areas of possible inaccessible contamination, including features such as buried pipes or pipelines; and
  - Pre-operational background radiation levels at and near the site.

Records not utilized to determine occupational dose that require a 3 years retention period as specified in 10 CFR §20.2103:

- Area beta-gamma measurements and associated instrument calibrations not utilized to determine employee dose;
- Equipment release records and associated instrument calibrations
- Instrument daily function check records;
- Alpha contamination surveys eating areas; and
- Personnel contamination surveys frisking stations

Duplicates of all significant records will be maintained in the corporate office or other off-site location. The RSO will be responsible for ensuring that the required records are maintained and controlled with adequate safeguards against tampering and loss.

5.2.4 Safety and Environmental Review Panel (SERP)

Uranium One currently possesses a Performance Based License (PBL) and has a Safety and Environmental Review Panel (SERP) which functions to fulfill the requirements of existing license condition 9.4. The SERP process and procedures that will apply to the proposed project are described in Section 5.2.2 of the LRA for SUA-1341.

5.2.5 Reporting

Reporting will be consistent with the requirements of 10 CFR 20 Subpart M and 10 CFR §40.64 and §40.65. The following specific reporting requirements will be implemented:

- Reports of theft or loss of licensed material (10 CFR §20.2201);
- Notification of incidents (10 CFR §20.2202);
- Reports of exposures, radiation levels, and concentrations of radioactive material exceeding the constraints or limits (10 CFR §20.2203);
- Reports of planned special exposures (10 CFR §20.2204);
- Reports to individuals of exceeding dose limits (10 CFR §20.2205);
- Reports (10 CFR §40.64);
- Effluent monitoring reporting requirements (10 CFR §40.65); and
- Requirements for advance notice of export shipments of natural uranium (10 CFR §40.66).

An annual report will be prepared and submitted to NRC based on the guidance contained in NUREG-1569. The annual report will contain the following information:

- ALARA audit report;
- The land use survey;
- A summary of monitoring data;
- The corrective action program report;
- The semiannual effluent and environmental monitoring report required by 10 CFR §40.65; and
- The SERP information.

5.2.6 Radioactive Materials Postings

Uranium One requests an exemption from the requirements of Section 20.1902(e) of 10 CFR 20 for areas within the proposed Ludeman Project facilities, provided that all

entrances to the facility are conspicuously posted in accordance with Section 20.1902(e) and with the words, "ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL." This additional condition would be consistent with license condition 9.11 of SUA-1341.

5.2.7 Historic and Cultural Resources Inventory

As addressed in License Condition 9.9 to License SUA-1341, Uranium One will administer a historic and cultural resources inventory before engaging in any development activity not previously assessed by NRC or any cooperating agency. Any disturbances to be associated with such development will be addressed in compliance with the National Historic Preservation Act (NHPA) and the Archeological Resources Protection Act. Uranium One will cease immediately any work resulting in the discovery of previously unknown cultural artifacts to ensure that no unapproved disturbance occurs. Uranium One will notify appropriate authorities per any license conditions and will not go forward without appropriate approvals from NRC or other agencies as appropriate. Any such artifacts will be inventoried and evaluated, and no further disturbance will occur until authorization to proceed has been received. Uranium One recognizes that the NHPA environment is not static, but rather is ongoing up to and through final license termination.

5.3 MANAGEMENT AUDIT AND INSPECTION PROGRAM

The management audit and inspection program for the proposed Ludeman Project will be the same as that described in Section 5.3 of the LRA for SUA-1341.

5.3.1 Surge Pond Inspections

Surge ponds at the proposed Ludeman Project will be inspected in accordance with NRC Regulatory Guide 3.11. Engineering data related to the design, construction, and operation of the surge ponds will be kept on-site and available for reference and inclusion in inspection reports. The following section describes the routine inspections for the surge ponds.

5.3.1.1 Inspection Frequency and Reporting

Two small wastewater surge ponds are planned for the each of the three proposed Ludeman Satellite facilities as discussed in Section 4. During operations, the leak detection standpipes will be checked for evidence of leakage on a weekly frequency. Visual inspection of the pond embankments, fences and liners and the measurement of pond freeboard will be performed on the same frequency. Anytime fluid is detected in a leak detection system standpipe, a sample of the solution will be obtained and analyzed

for chloride, conductivity, pH and uranium. Should the analyses indicate that the surge pond is leaking (by comparison to chemical analyses of pond water), the following actions will be taken:

- The WDEQ and NRC will be notified by telephone within 48 hours of leak verification;
- The level of the leaking pond will be lowered by transferring its contents into the adjacent surge pond. While lowering the water level in the pond, inspections of the liner will be made to determine the cause and location of the leakage. The area of investigation first centers around the pond area specific for the particular standpipe which contains fluid. Each lined surge pond will have six leak detection standpipes. Therefore, the area of leakage will be readily identifiable; and
- Once the source of the leakage is found, the liner will be repaired and water will be reintroduced to the pond to check the adequacy of the repair. Water in the leak detection standpipes will be monitored on a daily basis while refilling the pond.

A written report will be submitted to the WDEQ and NRC within 30 days of correcting the leakage. The report will include analytical data and will describe the cause of the leakage, corrective actions taken and the results of those actions.

5.4 RADIATION SAFETY STAFF QUALIFICATIONS

The requirements for education, experience, and training for the radiation safety staff for the proposed Ludeman Project will be the same as that described in Section 5.4 of the LRA for SUA-1341.

5.5 RADIATION SAFETY TRAINING

The radiation safety training program for visitors, contractors, employees, and supervisors for the proposed Ludeman Project will be the same as that described in Section 5.5 of the LRA for SUA-1341.

5.6 SECURITY

Uranium One is committed to:

- Providing employees with a safe, healthful, and secure working environment;
- Maintaining control and security of NRC-licensed material;
- Ensuring the safe and secure handling and transporting of hazardous materials; and

- Managing records and documents that may contain sensitive and confidential information.

The NRC requires licensees to maintain control over licensed material (i.e., natural uranium ("source material") and byproduct material defined in 10 CFR §40.4). 10 CFR 20, Subpart I, *Storage and Control of Licensed Material*, requires the following:

- §20.1801 Security of Stored Material - The licensee shall secure from unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.
- Control of Material not in Storage - The licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage.

Stored material at the proposed Ludeman Project would include byproduct materials awaiting disposal. Examples of material not in storage would include loaded ion exchange resin removed from the restricted area for transfer to the Willow Creek CPP for elution and barren ion exchange resin returned to the Ludeman Satellite facilities.

5.6.1 License Area and Facility Security

The active recovery areas will be controlled with fences and appropriate signs. All areas where source or byproduct materials are handled will be fenced. A 24-hour-per-day, seven-day-per-week staff will be on duty at the proposed Satellite facilities.

Facility operators will perform an inspection to ensure the proper storage and security of licensed material at the beginning of each shift. The inspection will determine whether all licensed material is properly stored in a restricted area or, if in controlled or unrestricted areas, is properly secured. If licensed material is found outside a restricted area, the operator will ensure that it is secured, locked, moved to a restricted area, or kept under constant surveillance by direct observation of appropriate site personnel. The results of this inspection will be properly documented.

All Satellite facility entrances will be locked during off-shift hours. All visitors will be required to sign the access log and indicate the purpose of their visit and the employee to be visited. The person being visited will be responsible to supervise the visitor(s) at all times when they are on site. Visitors will only be allowed at the facility during regular working hours unless prior approval is obtained from the General Manager, Wyoming Operations.

5.6.2 Transportation Security

Uranium One will routinely receive, store, use, and ship hazardous materials as defined by the U.S. Department of Transportation (DOT). In addition to the packaging and shipping requirements contained in the DOT Hazardous Materials Regulations (HMR), 49 CFR 172, Subpart I, *Security Plans*, requires that persons that offer for transportation or transport certain hazardous materials develop a Security Plan. Shipments may qualify for this DOT requirement under the following categories:

- §172.800(b)(4) - A shipment of a quantity of hazardous materials in a bulk package having a capacity equal to or greater than 13,248 L (3,500 gallons) for liquids or gases or more than 13.24 cubic meters (468 cubic feet) for solids;
- §172.800(b)(5) - A shipment in other than a bulk packaging of 2,268 kg (5,000 pounds) gross weight or more of one class of hazardous material for which placarding of a vehicle, rail car, or freight container is required; and
- §172.800(b) (7) - A quantity of hazardous material that requires placarding under the provisions of subpart F.

DOT requires that Security Plans assess the possible transportation security risks and evaluate appropriate measures to address those risks. All hazardous materials shippers and transporters subject to these standards must take measures to provide personnel security by screening applicable job applicants, prevent unauthorized access to the hazardous materials or vehicles being prepared for shipment, and provide for en route security. Companies must also train appropriate personnel in the elements of the Security Plan.

Transport of licensed/hazardous material by Uranium One employees will generally be restricted to moving IX resin from a Satellite facility to the Willow Creek facility or transferring contaminated equipment between company facilities. The goal of the driver, cargo, and equipment security measures is to ensure the safety of the driver and the security and integrity of the cargo from the point of origin to the final destination by:

- Clearly communicating general point-to-point security procedures and guidelines to all drivers and non-driving personnel;
- Providing the means and methods of protecting the drivers, vehicles, and cargo while on the road; and
- Transportation security risks will be documented and SOPs concerning these risks will be strictly followed.

For the security of all tractors and trailers, the following procedures will be adhered to:

- If material is stored in the vehicle, access must be secured at all openings with locks and/or tamper indicators;
- Off-site tractors will always be secured when left unattended with windows closed, doors locked, the engine shut off, and no keys or spare keys in or on the vehicle; and
- The unit is to be kept visible by an employee at all times when left unattended outside a restricted area.

The security guidelines and procedures will apply to all transport assignments. All drivers and non-driving personnel will be expected to be knowledgeable of, and adhere to, these guidelines and procedures when performing any load-related activity.

5.7 RADIATION SAFETY CONTROLS AND MONITORING

Uranium One has a strong corporate commitment to and support for the implementation of the radiological control program at the proposed project facilities. This corporate commitment to maintaining personnel exposures ALARA will be incorporated into the radiation safety controls and monitoring programs described in the following sections.

5.7.1 Effluent Control Techniques

5.7.1.1 Gaseous and Airborne Particulate Effluents

5.7.1.1.1 Gaseous Effluents - Radon Gas

Under routine operations, the only radioactive effluent at the proposed Satellite facilities will be radon-222 gas from the production solutions. The radon-222 is found in the pregnant and barren lixiviant that will be generated in the wellfield and piped to one of the proposed Satellite facilities. The production flow will be directed to the Satellite facilities for separation of the uranium by passing the recovery solution through pressurized downflow IX units. The vents from the individual vessels will be connected to a manifold that will be exhausted outside the facility building.

Venting radon gas to the atmosphere outside of the Satellite facility minimizes personnel exposure. Small amounts of radon-222 may be released in the facility during solution spills, filter changes, IX resin transfer operations and maintenance activities. The facility will be equipped with exhaust fans to remove any radon that may be released in the buildings. No significant personnel exposure to radon gas is expected based on operating

experience from the Willow Creek facilities. Ventilation and effluent control equipment will be inspected for proper operation as recommended in USNRC Regulatory Guide 3.56 (USNRC, 1986). Ventilation and effluent control equipment inspections will be conducted during radiation safety inspections as discussed in Section 5.3 of the LRA for SUA-1341.

Monitoring for combined facility and wellfield releases at the site airborne monitoring stations will be accomplished through the use of Track-Etch radon cups, as discussed in Section 5.7.7. Monitoring for radon gas releases from the facility buildings and ventilation discharge points is not practicable. 10 CFR §20.1302 provides that demonstration by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from licensed operations does not exceed the annual dose limit of 100 mrem. Regulatory Guide 8.37, Section 3.3 notes that where monitoring effluents points is not practicable, a licensee should estimate the magnitude of these releases and include these estimated releases in demonstrating compliance with the annual dose limit.

As discussed in Section 7.3 of this TR, Uranium One used MILDOS-Area to model the dose from facility operations resulting from releases of radon gas. The proposed project Satellite facilities will include pressurized downflow ion exchange columns, which do not routinely release radon gas except during resin transfer and column backwashing. In these systems, the majority of radon released to the production fluid stays in solution and is not released. The radon which is released is generated by occasional venting of process vessels and tanks, small unavoidable leaks in ion exchange equipment, and maintenance of equipment. For the purposes of determining the source term for MILDOS-Area, radon gas release was estimated as 10 percent of the radon-222 in the production fluid from the wellfields and an additional 10 percent in the ion exchange circuit in the Satellite facilities. Release of radon-222 at this concentration did not result in significant public dose. The wellfield maximum Total Effective Dose Equivalent (TEDE) of 1.6 mrem/yr. occurrs during year 3 at residence 3 in the -northwestern property boundary of the Leuenberger Facility and is 1.6 percent of the public dose limit of 100 mrem. The TEDE at the closest residence in the proposed project area occurrs in year 3 of operations and was 0.70 mrem/yr.

The MILDOS model inputs will be used to estimate the radon gas released to the environment, which will be reported in the Semiannual Radiological Effluent and Environmental Monitoring Reports required under 10 CFR Part 40.65. Section 7.3.1.1 discusses the factors and equations used to estimate source term contributions to the total radon effluent releases from the proposed Ludeman facilities. These individual source terms include radon released due to production releases during operations, restoration releases, new wellfield releases, and releases due to resin transfer. On a semiannual basis, the operational history of the proposed Ludeman facilities will be used to estimate the radon gas releases due to operations for the period. The following specific data for each

reporting period will be applied to the source term estimate methodology to determine radon gas releases:

- Production Releases - Actual average production flow rate and operating factor for the period;
- Restoration Releases - Actual average restoration flow rate and operating factor for the period;
- New Wellfield Releases - Total number of new wellfields started up during the period; and
- Resin Transfer Releases - Total number of resin transfers from Satellite facilities during the period.

5.7.1.1.2 Airborne Particulates

The final processing of the uranium to produce yellowcake will be performed at Willow Creek CPP. There are no anticipated sources for airborne particulates from the proposed project.

5.7.1.1.3 Laboratory Emissions

Laboratory areas will be used for the analysis of groundwater and process samples. Most of the analytical load for the laboratory will consist of routine semimonthly analysis of monitor well samples for chloride, conductivity, and total alkalinity. In laboratory areas where reagents are in use or fumes could be generated by the analytical method in use, laboratory fume hoods will be used if necessary to control emissions. Process samples will be analyzed within the restricted area and fumes hoods will be used as necessary to control emissions.

5.7.1.2 Liquid Effluents

The production bleed and water from restoration are the primary sources of liquid waste as previously discussed in Section 4. Water from these processes will be routed to a reverse osmosis system (RO) for treatment. A portion of the resulting permeate from the RO will be routed back to the production and restoration injection streams and the remainder will be recycled in the plant, used beneficially, or disposed of. Brine will be routed to surge ponds and subsequently disposed of in Class I deep disposal wells..

5.7.1.2.1 Liquid Effluent Accidents

5.7.1.2.1.1 Responsibilities

The RSO will be charged with the responsibility to develop and oversee implementation of appropriate procedures to address spills of byproduct material. Personnel representing the engineering and operations functions will assist the RSO in this effort. Basic responsibilities of plant management and the RSO in this regard will include:

Identification of potential spill sources including lessons learned from review of past incidents of spills.

- Assignment of resources and manpower;
- Responsibility for materials management and inventory;
- Establishment of spill reporting procedures and visual inspection programs;
- Establishment of employee emergency response training programs;
- Responsibility for program implementation and subsequent review and updating; and
- Review of new construction and process changes that may require updating of spill prevention and control programs.

5.7.1.2.1.2 Failure of Process Tanks

Leaks from failures of process tanks will be contained within the Satellite facility. Where it is feasible, process area within the Satellite facility will have secondary containment consisting of concrete curbs. Secondary containment basins will drain to sumps which will allow the transfer of the spilled solutions to appropriate tankage, surge ponds or directly to the deep well injection system. In addition, an overall facility containment berm will be incorporated into the building foundation which will contain spills during a catastrophic event or spills from areas where it is not feasible to include secondary containment berms.

5.7.1.2.1.3 Surface Releases between the Wellfield and Satellite Facilities

The most common form of surface releases from in-situ recovery operations occurs from breaks, leaks, or separations within the piping system that transfer recovery fluids between the CPP and the wellfield. These leaks will generally be limited to small releases due to engineering and instrumentation controls at the proposed project. Instrumentation and controls will include leak detection sensors in header houses, valve manholes, and wellheads, as well as pressure monitoring instrumentation on pipelines which will trigger

alarms and automatic shutdown in the case of an upset condition. In general, piping within the wellfield will be constructed of PVC or HDPE pipe with butt welded joints, or equivalent. All pipelines will be hydrostatically tested according to manufacturer's specifications and industry standards prior to final burial. In the event of leakage from the fitting, the defective component will be replaced. Prior to backfilling, a final inspection of all pipe and appurtenances will be conducted. In order to prevent spills of mining solutions, the following precautions will be taken.

- Piping and associated fittings will only be constructed of materials that are chemically compatible, able to withstand the expected operating pressures, and compatible with ambient conditions;
- Wellfield pipelines and manifolds will be pressure checked before being placed into operation and after significant repairs;
- Regular inspections of operating wellfields will be conducted as outlined in Section 5.3.3. The entire plant also will be inspected at least daily when operating as discussed in Section 5.3.1; and
- Automated monitoring will be installed in so any significant deviations in operating parameters will signal alarms and automatic shutdown.

Each operating header house will be inspected at least once per week by the operations staff with the results documented. The inspector will look for the following:

- Leaks of lixiviant in the module building;
- Failing pipes and fittings;
- Conditions that may lead to a release of lixiviant;
- Proper capping of wellheads and pipes that are not in use;
- Exposed scale that could become airborne; and
- Exposed piping that is supposed to be buried.

Any condition discovered during the inspection that may lead to the spread of contamination will be repaired in a timely manner or made safe. Results of the inspection will be made available to the RSO and will be maintained for the life of the license. At least once per year, the Manager of Health, Safety, and Environmental Affairs will convene the SERP to review the cause of recent spills. The SERP will consist of at least three individuals with experience in operations. After reviewing the causes of recent spills, the SERP will send a report to the facility manager detailing reasonable recommendations on how to prevent and minimize the size of future spills.

5.7.2 External Radiation Exposure Monitoring Program

5.7.2.1 Gamma Surveys

External gamma radiation surveys will be performed routinely at each of the proposed Ludeman Satellite facility facilities. The required frequency will be weekly in designated Radiation Areas and areas that exceed the action level of 2.0 mrem per hour and monthly in all other areas of the facility. Surveys will be performed at worker occupied stations and areas of potential gamma sources such as tanks and filters. Uranium One will establish and post as a Radiation Area any area, accessible to workers, in which levels could result in a gamma exposure rate in excess of 5 mrem in 1 hour. An investigation will be performed to determine the probable source and survey frequency for areas exceeding 5.0 mrem per hour is increased to monthly. Records will be maintained of each investigation and the corrective action taken. If the results of a gamma survey identified areas where gamma radiation is in excess of levels that delineate a "radiation area," access to the area will be restricted and the area will be posted as required in 10 CFR §20.1902 (a).

External gamma surveys will be performed with survey equipment that meets the following minimum specifications:

1. Range - Lowest range not to exceed 100 microRoentgens per hour (μR/hr) full-scale with the highest range to read at least five milliRoentgens per hour (mR/hr) full-scale; and
2. Battery operated and portable;

Examples of satisfactory instrumentation that meets these requirements are the Ludlum Model 3 survey meter with a Ludlum Model44-38 probe or equivalent. The Model 3 is a general purpose survey meter with a meter scale of 0 to 2 mrem/hr and scale multiplier adjustments of X 0.1, X 1.0, X 10, and X 100. Accordingly, the effective range of this survey meter and probe is 0 – 200 mrem/hr. The Model 44-38 has a sensitivity of 1,200 cpm per mrem/hr and backgrounds of 20 cpm (beta shield closed) and 25 cpm open. Accordingly, the MDL for this instrument is approximately 30 μR/hr at twice background.

Gamma survey instruments will be calibrated at the manufacturer's suggested interval or at least annually as required in SUA-1341 and will be operated in accordance with the manufacturer's recommendations. Instrument checks will be performed as summarized in the following schedule:

- Physical check – Daily when in use;
- Battery Check (if applicable) – Daily when in use;

- Response source check (± 20%) – Daily when in use;
- Calibration verification – Daily when in use; and
- Background measurement – Daily or before each use

Proposed survey locations for the proposed Satellite facilities are shown on Figure 5-2. The proposed survey locations were selected based on experience with external exposure rates at operating ISR facilities. Areas where elevated gamma exposure rates are typically found include the ion exchange columns and filter housings that remove solid materials from the production and injection streams. These solids historically contain elevated concentrations of radium-226, which may result in elevated gamma exposure rates. In some cases, the gamma dose rates from these components may exceed five mrem per hour and may require posting as Radiation Areas. Radiation Areas are not usually encountered in wellfield areas of ISR facilities unless filtration equipment is installed in header houses. The proposed project will be utilizing a bag filtration system within the header houses.

The processing, drying and packaging of yellowcake activities are not proposed to be conducted at the proposed project and would not require beta surveys as recommended in USNRC Regulatory Guide 8.30, Section 1.4. Uranium One plans to ship loaded resin to the Willow Creek CPP for further processing into yellowcake..

5.7.2.2 Personnel Dosimetry

10 CFR §20.1502 (a)(1) requires exposure monitoring for "Adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of the limits in §20.1201 (a)". Ten percent of the dose limit would correspond to a Deep Dose Equivalent (DDE) of 0.5 rem.

Uranium One will determine monitoring requirements in accordance with the guidance contained in USNRC Regulatory Guide 8.34 (USNRC, 1992). Based on the experience of Willow Creek and other ISR operations, Uranium One believes that it is not likely that any employee working at the proposed project will exceed 10 percent of the regulatory limit (i.e., 500 mrem/yr).

- The typical wellfield dose rate will not exceed background gamma exposure rates except immediately adjacent to wellheads and header houses, where scale formed on the inside surfaces of piping may contain radium-226, resulting in increased gamma exposure rates. Experience at operating ISR facilities indicates that annual doses for wellfield workers generally do not exceed one percent of the regulatory limit (i.e., 50 mrem/yr.); and
- Satellite facility workers may be exposed to elevated gamma exposure rates during operations and maintenance activities in the facility. Experience at

operation ISR facilities indicates that annual doses to Satellite facility workers are generally less than ten percent of the regulatory limit.

Although monitoring of external exposure may not be required in accordance with §20.1201(a) due to the low exposure rates typically encountered at ISR facilities, Uranium One will issue dosimetry initially to all the proposed project employees and will exchange them on a quarterly basis. Once an operating history of expected employee doses for the proposed project is developed, Uranium One may reduce the number of employees in the dosimetry program in conformance with 10 CFR 20.1201.

Dosimeters will be provided by a vendor that is accredited by National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology as required in 10 CFR § 20.1501. The dosimeters will have a range of 1 mR to 1000 R. Dosimeters will be exchanged and read on a quarterly basis.

Results from personnel dosimetry will provide the individual Deep Dose Equivalent (DDE) for use in determining Total Effective Dose Equivalent (TEDE). The TEDE is defined in Regulatory Guide 8.30 as the sum of the DDE and the committed effective dose equivalent (CEDE) for internal exposures. Determination of the CEDE is discussed in further detail in Section 5.7.4.

5.7.3 In-Facility Airborne Radiation Monitoring Program

5.7.3.1 Airborne Uranium Particulate Monitoring

Routine airborne uranium particulate sampling is not proposed for the Satellite facilities at Ludeman because there are no elution, precipitation, or drying activities in these facilities that would be a potential source of airborne uranium. However, airborne uranium particulate monitoring may be necessary during some maintenance or other activities performed under an RWP. Airborne uranium monitoring required for these activities will be performed in accordance with the approved program under SUA-1341.

5.7.3.2 Radon Daughter Concentration Monitoring

Surveys for radon daughter concentrations will be conducted in the operating areas of the proposed Satellite facilities on a monthly basis. Sampling locations will be determined in accordance with the guidance contained in USNRC Regulatory Guide 8.25. Proposed radon daughter sampling locations for the proposed Ludeman Project Satellite facilities are shown on Figure 5-2.

Samples will be collected with a low volume air pump (e.g., lapel sampler) and then analyzed with an alpha scaler using the Modified Kusnetz method described in ANSI-

N13.8-1973. Samplers will be calibrated at the manufacturer's suggested interval or annually with a digital mass flowmeter or other primary calibration standard. Instruments utilized in determining gross alpha count for radon daughter concentration samples will be function checked prior to use to ensure proper operations.
Results of radon daughter sampling are expressed in Working Levels (WL) where one WL is defined as any combination of short-lived radon-222 daughters in one liter of air without regard to equilibrium that emit 1.3 x 10^5 MeV of alpha energy. The Derived Air Concentrations (DAC) limit from Appendix B to 10 CFR §§ 20.1001 - 20.2402 for radon-222 with daughters present is 0.33 WL. Uranium One will establish an Action Level of 25 percent of the DAC or 0.08 WL. Radon daughter monitoring results in areas with an average concentration in excess of the action level will result in an investigation of the cause and an increase in the sampling frequency to weekly until the radon daughter concentration levels do not exceed the action level for four consecutive weeks.

The results of radon daughter concentration monitoring will be used to determine the Committed Effective Dose Equivalent (CEDE) or internal exposure as described in detail in Section 5.7.4.2.

Lower limits of detection (LLDs) will be established to ensure the ability to detect < 10% of applicable DAC. For radon daughters, this will be < 0.03 WL. The following equipment will be used to obtain air samples.

- Breathing zone (lapel) sampler (0 to 5 lpm) such as a GilAir5 or equivalent.

Air samplers will be calibrated as per manufacturer recommendations or at least semiannually with a mass flow meter or other primary calibration standard. A record shall be kept of all calibrations and radon daughter surveys by the RSO until license termination and in a form compliant with NRC Regulatory Guide 8.7, Instructions for Recording and Reporting Occupational Radiation Exposure, Revision 1.

Radon daughter in Air will be determined via the modified Kusnetz method as follows:

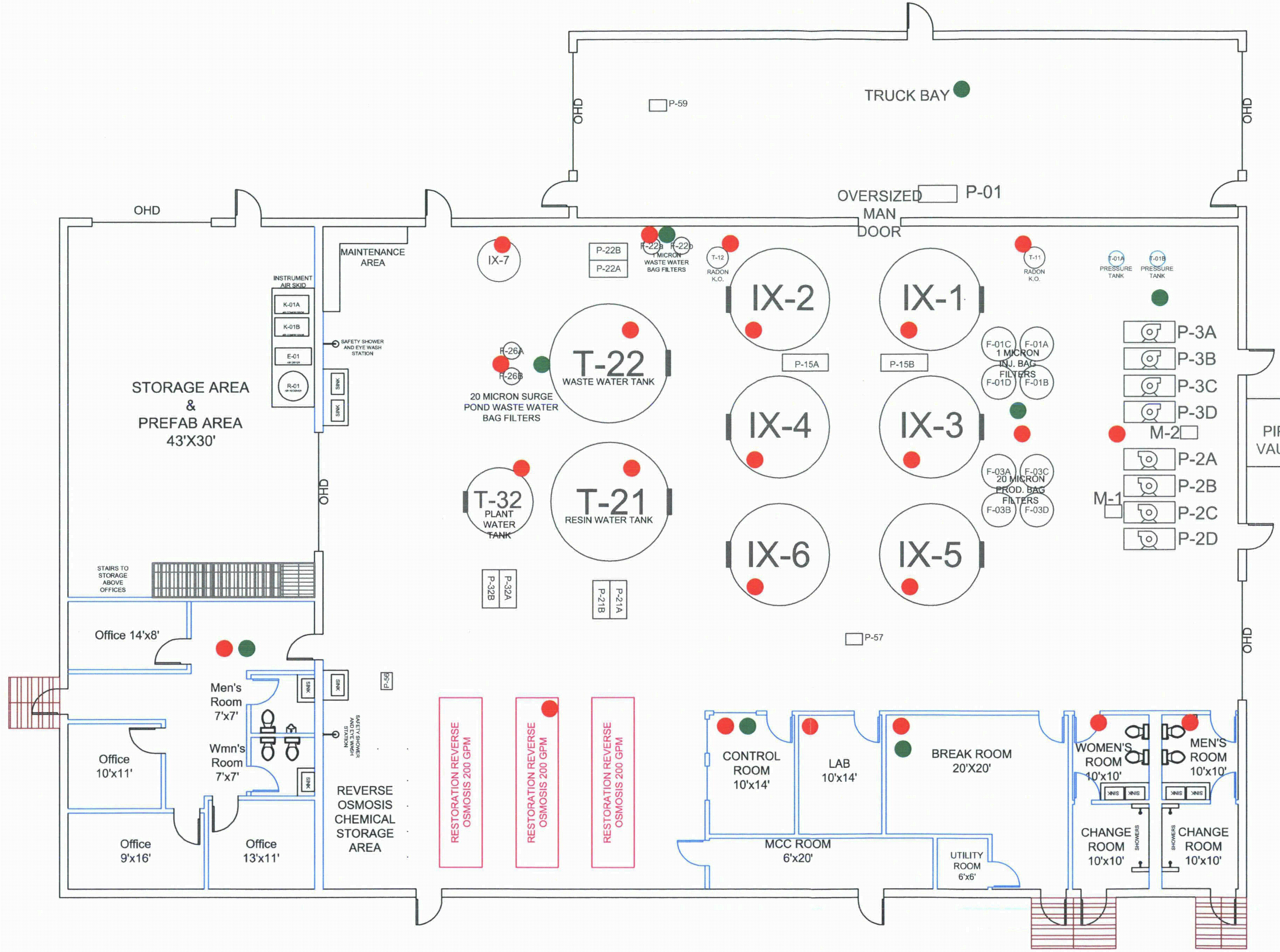
$$WL = \frac{\text{Sample cpm - background cpm}}{(\text{Eff})(\text{Vol})(\text{TF})}$$

Where:

cpm	=	Counts per minute (Sample – background)
Eff	=	Instrument counting efficiency
SAF	=	Filter paper self absorption factor
Vol	=	Total air volume pumped through filter (flow rate in liters x sample time in minutes)
TF	=	Time factor ("Kusnetz" factor from table @ 40 -90 minutes after sampling)

5.7.3.3 Respiratory Protection Program

Respiratory protective equipment will be supplied by Uranium One for activities where engineering controls may not be adequate to maintain acceptable levels of airborne radioactive materials or toxic materials. Use of respiratory equipment at the proposed project facilities will be in accordance with the Respiratory Protection Program described in Section 5.7.4.4 of the LRA for SUA-1341. The Uranium One Respiratory Protection Program is designed to implement the guidance contained in USNRC Regulatory Guide 8.15 (USNRC, 1999) and USNRC Regulatory Guide 8.31.



LEGEND

- Radon Testing Location
- Gamma Survey Location

N

6' 0 12'

VERIFY SCALE

SCALE : 1"=12'

uranium one
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907 North Poplar St., Suite 260, Casper, WY 82601 307-234-8235

Ludeman Satellite Plant
Radiological Survey Locations

Date: 10/15/09	By: CM	Checked:	Approved:

Rev. No.	Description	Date	By
0	Initial Draft	10/15/09	CM
1	REVISIONS	12/28/09	CM

TREC, Inc.
Engineering & Environmental Management

Figure: 5-2

5.7.4 Exposure Determination and Records Calculations

Employee exposure to radiation will be monitored and recorded in accordance with 10 CFR §20.1502 and §20.1201 and Regulatory Guides 8.30 and 8.34. Routine employee external exposures will be determined and recorded for those employees likely to receive more than 10 percent of the allowable occupational dose limit (i.e., 0.5 rem or 500mrem). During initial operation of the proposed project all workers will be monitored for external and internal exposure. Once an adequate exposure history is established, Uranium One may discontinue monitoring for worker classifications that have been shown to have no likelihood of exceeding 10 percent of the allowable occupational dose limit. External exposures will be determined using personnel dosimetry as discussed in Section 5.7.2.2. Internal exposures will be determined and recorded for internal exposure from radon daughters or uranium.

The following is a discussion of the exposure determination methods and documentation of results.

5.7.4.1 Natural Uranium Internal Exposure

Since the proposed project consists of the ion exchange process with no elution, precipitation, or drying activities that would be a potential source of airborne uranium, routine airborne uranium sampling is not proposed. However, airborne uranium monitoring may be necessary during some maintenance or other activities performed under an RWP. In these cases, exposure calculations for airborne natural uranium will be performed using the intake method from USNRC Regulatory Guide 8.30, Section 2. The intake is calculated using the following equation:

$$I_u = b\sum_{i=1}^{n}\frac{X_i \times t_i}{PF}$$

where:

I_u = uranium intake, (µg or µCi)

X_i = average concentration of uranium in breathing zone, (µg/m^3, µCi/m^3)

t_i = time that the worker is exposed to concentrations X_i, (hrs)

b = breathing rate, 1.2 m^3/hr

PF = the respirator protection factor, if applicable

n = the number of exposure periods during the week or quarter

The intake for uranium will be calculated and recorded. The intakes will be totaled and entered onto each employee's Occupational Exposure Record.

Intake of soluble uranium will be limited to 10 mg per week per 10 CFR 20.1201(e). Accordingly, at an assumed specific activity of 0.67 μCi/gram for natural uranium (10 CFR 20, Appendix B, footnote 3), the weekly soluble intake limit is 6.7 E-3 μCi. Compliance to this requirement for work conducted under an RWP will be documented by recording worker airborne exposure in DAC–hrs, whenever long lived particulate concentrations in air are determined to be ≥ 10 % DAC. An action level of 25% DAC will be established requiring RSO investigation and potential corrective actions. Assignments of positive airborne exposures will be reviewed weekly. Accordingly, any exposures to soluble uranium > 5 % of the 10 mg/week limit will in fact be recorded (as DAC–hrs) and controlling exposure to 25% of DAC ensures both that the 10 mg/week limit is not exceeded and ALARA.

The data required to calculate internal exposure to airborne natural uranium will also include the following:

- Time of Exposure Determination - Exposures during non-routine work (i.e., work requiring an RWP) will be based upon actual time.
- Airborne Uranium Activity Determination - Airborne uranium activity for non-routine work will be determined from surveys performed as described in Section 5.7.3.1.

5.7.4.2 Radon Daughter Internal Exposure

Exposure calculations for airborne radon daughters will be performed using the intake method from USNRC Regulatory Guide 8.30, Section 2. The radon daughter intake will be calculated using the following equation:

$$I_r = \frac{1}{170} \sum_{i=1}^{n} \frac{W_i \times t_i}{PF}$$

where:

I_r	=	radon daughter intake, working-level months
t_i	=	time that the worker is exposed to concentrations W_i (hr)
W_i	=	average number of working levels in the air near the worker's breathing zone during the time (t_i)
170	=	number of hours in a working month
PF	=	the respirator protection factor, if applicable
n	=	the number of exposure periods during the year

The data required to calculate exposure to radon daughters will be determined as follows:

- Time of Exposure Determination – In general, 100% occupancy time will be used to determine exposures. Using this method to determine time of exposure, each worker is assumed to have spent their entire work shift in the survey area(s). The occupancy time determinations for each worker will be based on the actual time worked during the monitoring period. This approach generally results in a conservative (i.e., higher than actual) estimate of internal exposure to radon daughters because it does not account for time the worker may have spent outside the work area, such as during breaks and meals.

Alternatively, the RSO may perform a time study to determine the average time of exposure for each classification of worker. Under this approach, the RSO will have a representative population of each classification of worker track their time spent in different areas of the facility. The time study will be performed for an extended period (usually one month) and will provide the RSO with a percentage of time spent in each area for each classification of worker. If time studies are employed to determine time of exposure, they will be updated annually to account for any changes. Exposures during non-routine work (i.e., work requiring an RWP) will be based upon actual time.

- Radon Daughter Concentration Determination - Radon-222 daughter concentrations will be determined from surveys performed as described in Section 5.7.3.2. The working-level months for radon daughter exposure will be calculated and recorded. The working-level months will be totaled and entered onto each employee's Occupational Exposure Record.

Exposures to radon daughters will be compared to the DAC for radon daughters from Appendix B of 10 CFR §§20.1001 - 20.2401 (i.e., 0.33 WL).

5.7.4.3 External Exposure

Occupational exposure to external gamma and beta radiation will be measured using personnel dosimeters such as Thermoluminescent Dosimeters (TLD) or Optically Stimulated Luminescence (OSL) dosimeters as discussed in Section 5.7.2.2. Consistent with 10 CFR §20.1502 and Regulatory Guide 8.34, occupational exposure to external radiation will be used to determine the TEDE for employees whose work locations or functions may be expected to exceed 10 percent of the occupational exposure limits. During initial operation of the proposed project, all workers will be monitored for external exposure once an adequate exposure history is established.

5.7.4.4 Prenatal and Fetal Exposure

10 CFR §20.1208 requires that licensees ensure that the dose to an embryo/fetus during the entire pregnancy from occupational exposure of a declared pregnant woman does not exceed 0.5 rem (500 mrem). Licensees are also required to make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman that would satisfy the 0.5 rem limit. The dose to the embryo/fetus is calculated as the sum of (1) the deep-dose equivalent to the declared pregnant woman, and (2) the dose to the embryo/fetus from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman.

The dose equivalent to the embryo/fetus is determined by the monitoring of the declared pregnant woman. 10 CFR §20.1502(a)(2) requires monitoring the exposure of a declared pregnant woman when the external dose to the embryo/fetus is likely to exceed a dose from external sources in excess of 10 percent of the embryo/fetus dose limit (i.e., 0.05 rem/yr). 10 CFR 20.1502(b)(2) also requires that the licensee monitor the occupational intakes of radioactive material for the declared pregnant woman if her intake is likely to exceed a committed effective dose equivalent in excess of 0.05 rem/yr. Based on this 0.05 rem threshold, the dose to the embryo/fetus must be determined if the intake is likely to exceed 1 percent of ALI during the entire period of gestation.

Prior to declaration of pregnancy, the woman may not have been subject to monitoring based on the conditions specified in 10 CFR §20.1502. In this case, Uranium One will estimate the exposure during the period monitoring was not provided, using any combination of surveys or other available data (e.g., air monitoring, area monitoring, and bioassay). Exposure calculations will be performed as recommended in USNRC Regulatory Guide 8.36 (USNRC, 1992).

External Dose to the Embryo/Fetus - The deep-dose equivalent to the declared pregnant woman during the gestation period will be taken as the external dose for the embryo/fetus. The determination of external dose will consider all occupational exposures of the declared pregnant woman since the estimated date of conception and will be based on the methods discussed in Section 5.7.2.

Internal Dose to the Embryo/Fetus - The internal dose to the embryo/fetus will consider the exposure to the embryo/fetus from radionuclides in the declared pregnant woman and in the embryo/fetus. The dose to the embryo/fetus will include the contribution from any radionuclides in the declared pregnant woman (body burden) from occupational intakes occurring prior to conception. The intake for the declared pregnant woman will be determined as discussed in Sections 5.7.3.1 and 5.7.3.2.

5.7.4.5 Exposure Recording and Reporting

For employees that are monitored for internal and/or external exposure, recording and reporting of monitoring results is required in 10 CFR §20.2106(a) and §20.2206(b), respectively. Records of exposure monitoring results will be maintained for each monitored individual on an NRC Form 5 or equivalent.

In addition, 10 CFR §20.2104 requires a determination of the individual's current year dose at other facilities. Uranium One will obtain prior dose histories for all employees. Uranium One will obtain an NRC Form 4 signed by the individual to be monitored, or a written statement that includes the names of all facilities that monitored the individual for occupational exposure to radiation during the current year and an estimate of the dose received. Uranium One will attempt to verify the information provided by the individual. Uranium One will also attempt to obtain records of the individual's lifetime cumulative occupational radiation dose. This lifetime dose may be based on a written estimate or an up-to-date NRC Form 4 signed by the individual.

In accordance with 10 CFR §19.13(b), monitored employees will be advised in writing on an annual basis of their calculated TEDE. Additionally, any employee may request a written report of their exposure history at any time. These reports will be provided within 30 days of the request and will provide the information outlined in 10 CFR §19.13.

In accordance with 10 CFR §20.2205, if Uranium One is required to report to the NRC any exposure of an identified occupationally exposed individual or an identified member of the public to radiation or radioactive material under 10 CFR §20.2203 (Reports of exposures, radiation levels, and concentrations of radioactive material exceeding the constraints or limits) or 10 CFR §20.2204 (Reports of planned special exposures), Uranium One will also provided the employee(s) or identified member(s) of the public with a report of his or her exposure no later than the time that the report is submitted to the NRC.

5.7.5 BIOASSAY PROGRAM

Uranium One will implement a urinalysis bioassay program at the Ludeman Project as described in Section 5.7.5 of the LRA for SUA-1341. The Uranium One bioassay program meets the guidelines contained in USNRC Regulatory Guide 8.22 (USNRC, 1988). The primary purpose of a bioassay program is to detect uranium intake in employees who are potentially exposed to airborne uranium and to confirm the results of the airborne uranium particulate monitoring program (discussed in Section 5.7.3.1) and the internal exposure determination (discussed in Section 5.7.4.1). In the case of the proposed Satellite operations at Ludeman, there is little potential for airborne uranium since elution, precipitation, and drying activities will take place at the Willow Creek CPP. However, Satellite operators will be sampled at the same frequency as process area

workers (i.e., monthly). All new employees will submit an initial and termination bioassay sample.

5.7.6 Contamination Control Program

Uranium One will perform surveys for surface contamination in operating and clean areas of the proposed Satellite facilities in accordance with the guidelines contained in USNRC Regulatory Guide 8.30. Surveys for contamination of skin and personal clothing and surveys for release of equipment and materials will be performed in accordance with the current program approved in SUA-1341.

Table 5-1 provides a tabular summary of the proposed radiological monitoring program as well as the regulatory guidance provided in USNRC Regulatory Guide 8.30, "Health Physics Surveys In Uranium Mills".

Table 5-1: Ludeman Radiological Monitoring Program Summary

Type of Survey	Type of Area	Proposed Frequency	Reg. Guide 8.30 Recommended Frequency
Airborne Uranium	·Special maintenance	RWP breathing zone or area grab samples	·Extra breathing zone grab samples
Radon daughters	·Areas that exceed 0.08WL ·Areas that exceed 0.03WL ·Areas below 0.03WL	·Weekly radon daughter grab samples[1] ·Monthly radon daughter grab samples ·Monthly radon daughter grab samples	·Weekly radon daughter grab samples ·Monthly radon daughter grab samples ·Quarterly radon daughter grab samples
External radiation: Gamma	·Throughout Satellite facilities ·Radiation areas and areas in excess of 2 mr\hr action level.	·Quarterly ·Monthly[2]	·Semiannually ·Quarterly
Surface contamination	·Facility areas ·Eating rooms, change rooms, control rooms, office	·Daily walkthrough ·Weekly	·Daily ·Weekly
Skin and personal clothing	·Process workers who shower ·Process workers who do not shower	·Each exit from controlled area[3] ·Each exit from controlled area[3]	·Quarterly ·Each day before leaving
Equipment to be released	·Equipment to be released that may be contaminated	·Detailed survey before release	·Once before release
Packages containing yellowcake	·Packages	·Detailed survey before release	·Spot check before release
Ventilation	·All areas with airborne radioactivity potential	·Daily walkthrough	·Daily
Respirators	·Respirator face pieces and hoods	·Before reuse	·Before reuse

Notes

1. **Increased sampling frequency based upon administrative action level of 25% of the MPC or DAC.**
2. **Increased gamma survey frequency performed at administrative action level**
3. **All employees required to survey upon exit. Quarterly spot checks of >25% satellite personnel.**

5.7.7 Airborne Effluent and Environmental Monitoring Programs

5.7.7.1 Air Particulate

Preoperational air monitoring locations were used for baseline determination of air particulate concentrations as described in Section 2.9.6. Sampling locations are shown on Figure 2.9-39, Section 2.9. These locations were selected as recommended in Regulatory Guide 4.14 (USNRC, 1980), which calls for a minimum of three air monitoring stations at or near the site boundaries, one station at or close to the nearest occupiable structure within 10 kilometers of the site, and one station at a control or background location. Operational airborne uranium sampling is not proposed for the Satellite facilities because there are no elution, precipitation, or drying activities in these facilities that would be a potential source of airborne uranium.

5.7.7.2 Radon

Preoperational radon monitoring locations were located at the same locations as the preoperational air particulate monitoring stations. Baseline Rn-222 results indicated a relatively minor degree of spatial variability in radon concentrations across the site.

Operational radon monitoring will be accomplished at the five preoperational locations as recommended in Regulatory Guide 4.14. The control/background air monitoring station will be represented by station number LUD-5 as shown in Figure 2.9-39, Section 2.9. This location is at least one mile west/southwest (i.e., upwind) of the Satellite facility location and wellfield areas.

Monitoring will be performed using Track-Etch radon cups and will be exchanged on a quarterly basis. In addition to the manufacturer's Quality Assurance program, Uranium One will expose one duplicate radon Track Etch cup per monitoring period.

In addition to the environmental monitoring, the release of radon from process operations will be estimated using the source term method described in Section 7.3 and will be reported in the semi-annual effluent reports required by 10 CFR § 40.65.

Surface Soil - Operational soil sampling will be conducted on an annual basis. Locations will include each of the five environmental monitoring locations. Samples will be collected as discrete grab samples of surface soils as indicated in Table 2 of Regulatory Guide 4.14, and will be analyzed for U-nat, Ra-226, and Pb-210. Sampling depth will be 5 cm for consistency with Regulatory Guide 4.14 baseline soil sampling surveys conducted at the site.

Sediment - Operational sediment sampling will be conducted on an annual basis. Locations will include each of the surface water sampling locations discussed in Section 5.7.8.3. Samples will be analyzed for U-nat, Th-230, Ra-226, and Pb-210.

Subsurface Soil - Regulatory Guide 4.14 does not require subsurface soil sampling during operational phases of the site. Post operational subsurface soil samples will be taken following conclusion of operations and will be compared to the results of the preoperational monitoring program.

Vegetation and Food - Pre-operational vegetation samples from the proposed Ludeman Project areas were collected in 2008 at the locations described in Section 2.9.

Uranium One does not propose to perform operational vegetation sampling at the environmental monitoring stations. In accordance with the provisions of USNRC Regulatory Guide 4.14, Footnote (o) to Table 2 requires that "*vegetation and forage sampling need be carried out only if dose calculations indicate that the ingestion pathway from grazing animals is a potentially significant exposure pathway...*" defined as a pathway which would expose an individual to a dose in excess of 5 percent of the applicable radiation protection standard. This pathway was evaluated by MILDOS-Area and is discussed further in Section 7.3.

Direct Radiation - Environmental gamma radiation levels will be monitored continuously at the environmental monitoring stations (LUD-1 through LUD-5). Gamma radiation will be monitored through the use of environmental dosimeters obtained from a NVLAP certified vendor. The environmental dosimeter used for direct radiation measurements will be the InLight dosimeter from Landauer. The InLight has a lower limit of detection of 0.1 mrem. Dosimeters will be exchanged on a quarterly basis.

Deep Disposal Well Monitoring - Monitoring of liquid effluent disposed of through the deep disposal well(s) will be conducted in accordance with the Class I Underground Injection Control Permit(s) issued by the Wyoming Department of Environmental Quality-Water Quality Division.

5.7.8 Groundwater/Surface Water Monitoring Program

5.7.8.1 Program Description

During operations at the proposed Ludeman Project, a detailed water sampling program will be conducted to identify any potential impacts to water resources of the area. Uranium One's operational water monitoring program will include the evaluation of groundwater and surface water within the licensed area. This section describes well

development and sampling methods and proposed groundwater and surface water monitoring programs.

5.7.8.2 Groundwater Monitoring

The groundwater monitoring program is designed to detect excursions of lixiviant outside of the wellfield pattern area within the Production Zone or into the overlying and/or underlying water bearing strata.

5.7.8.2.1 Wellfield Baseline Sampling

The Restoration Target Values (RTV's) are determined from the baseline water quality data and are used to assess the effectiveness of ground water restoration activities. The average and range of baseline values determined for the wells completed in the Production Zone within the wellfield area constitute the RTV's.These wells will be sampled four times with a minimum of 2 weeks between samplings. Wells will be selected based on a density of one well per three acres of pattern area. The first and second sample events will include analyses for all WDEQ LQD Guideline 8, Appendix 1, parts III and IV parameters as shown in Table 5-3. The third and fourth sampling events will be analyzed for the Assay Suite B analytes approved in SUA-1341 (i.e., Total Dissolved Solids, sulfate, chloride, conductivity, total alkalinity, pH, arsenic, selenium, natural uranium, and Ra-226).

Data for each parameter are averaged for the wellfield. As discussed in the LRA for SUA-1341, outliers will be removed from the database as described in the following section. The overall average baseline water quality results for a mine unit will be used to define the restoration water quality target values for that particular mine unit.

Removal of Outliers from the Water Quality Data Base

Prior to any calculations for baseline mean, other statistics, or upper control limits, the water quality data base will be screened for outliers. Outliers are anomalously high or low values relative to the other values, which can compromise a data base. Outliers are typically caused by one of the following conditions:

- Transcription errors, either in the laboratory or in-house
- Analytical errors (multiplication errors, etc.)
- Incorrect units of measurements
- Sampling error

However, it is possible that the outlier may be a true value, being caused by natural water quality variability or geologic differences within the sampled aquifer. For this reason, the following procedures will be followed when analyzing the water quality data base for outliers:

- The data will first be screened visually, to identify obvious outliers, if present.
- The data will then be screened using a statistical analysis method. As approved in SUA-1341, Uranium One will use the tolerance-limit formula (Loftis, et al., 1987) as the method for outlier screening. This method is currently approved in SUA-1341 and is recommended in WDEQ Guideline No. 4, In Situ Mining. The tolerance-limit method used by Uranium One is as follows:

$X \pm Ks$ Where:

X = sample mean
K = tolerance factor, corresponding to $\gamma = 0.99$ and $\alpha = 0.001$
s = sample standard deviation

- Once an outlier is identified, either by the visual screening or by the tolerance-limit method, reasons for the outlier will be investigated. The analyzing laboratory will be contacted to see if the outlier could be a result of a calculation error, transcription error, or unit of measurement error. Errors in sampling will also be investigated. Hopefully, the error will be detected and the data point corrected. In a case where no explanation for the outlier can be reasonably found, the data point will be excluded if it fails the tolerance limit statistical screening.

If the data collected for the entire mine unit indicate that waters of different underground water classes (WDEQ-WQD Rules and Regulations, Chapter VIII) exist together, the data are not averaged together, but treated as sub-zones. Data within specific sub-zones are averaged. Boundaries of sub-zones, where required, are delineated at half-way between the sets of sampled wells which define the sub-zones.

5.7.8.2.2 Well Sampling Methods

Proper groundwater sampling procedures are critical to ensuring that water samples from monitor well are representative of water in the zone being monitored. This is needed to ensure environmental protection goals at ISR uranium mines are met. In order to ensure the accuracy of these monitoring efforts, strict compliance with groundwater sampling

procedures is necessary. This section provides methods of well development, water level determination, proper well sampling techniques, sample preservation and documentation, and QA/QC requirements proposed by Uranium One. These requirements will be followed for all samples obtained from private wells and monitor wells. These procedures were also used during baseline sampling events.

After well completion, wells will be developed by air flushing or pumping until water quality in terms of pH and specific conductivity appears to be stable and consistent with the anticipated water quality of the area. After development, wells will be sampled to obtain baseline water quality. Two casing volumes of water will be purged prior to sample collection to ensure that representative water is obtained.

The accurate determination of the static water level in monitor wells provides important information concerning aquifer water levels, pressure gradients and flow directions. Well static water levels are monitored using an electrical measuring line (an "e-line"). An e-line is a device that measures electrical conductance with two electrodes contained in a shielded probe. The probe is mounted to a graduated strip to allow measurement of the depth of water below point with defined elevation. The probe is slowly lowered into the well. When the probe contacts the water surface in the well, the circuit is completed and an audible device is actuated. The graduated strip can then be read by the sampler to determine the depth of ground water below the measuring point. The sampler will take water level readings of all monitor and baseline wells before sampling.

It is generally not possible to measure water level in existing private wells without disassembly of pumping and piping systems. If possible, the water level will be measured. If it is not possible to measure water level, the well will be purged for at least five minutes to evacuate any lines or existing pressure tanks of stagnant water. If any particulate matter is identified in the water, the well will be allowed to flow until it no longer contains any particulate.

During regional well sampling, all groundwater depth readings should be reported to within at least one-tenth of a foot. It is important to verify the e-line length by measuring with a steel tape after the line has been used for a long time, when the length has been altered due to repairs, or after it has been pulled hard in an attempt to free the line. If an e-line's length is altered by these causes, a correction factor should be written on the side of the e-line so readings may be properly adjusted.

Water that remains in the well casing between samples may not be representative of the formation water quality. The quality of water left in the casing between samples may be changed by sorption or desorption from casing materials, oxidation, or biological activity. Purging is required to remove this stagnant water and allow formation water into the well screen. Stabilization is considered achieved when the measurements of all parameters are

stable within a predetermined range. Parameters that Uranium One will monitor include pH, temperature, and specific conductivity.

The Wyoming WDEQ-LQD in Guideline 8, Section IV.A.4.b requires withdrawing at least two casing volumes of water prior to sampling. The sampler will document the pumping rate and the purging time. The LQD alternatively allows purging the well until pH, conductivity, temperature, and water level readings remain constant. The field sampler will document the changes in each field parameter against time in a tabular form. If recharge cannot match minimal pumping rates in a low permeability aquifer, then a sample can be retrieved by pumping the well dry once and then bailing the water that subsequently enters the well.

Accurate records of well purging will be maintained to document the number of casing volumes purged from the well before sampling. These records will include the casing volume (gallons), the pumping rate (gpm), and pumping start and stop times. The pumping rate can be determined with a flowmeter or by timing how long it takes to fill a five-gallon bucket or other container of a known volume.

The following formula will be used to calculate the number of gallons contained in one casing volume:

$$\textit{Casing Volume (Gals)} = (H) \times (R^2) \times (\pi) \times (0.052)$$

Where:

H = *Height of water in well (in feet)*
R = radius of the well (in inches)
$\pi = 3.1416$

The height of the water in the well = the total depth (TD) of the well in feet minus the depth to water in feet.

Field meters will be used to measure pH, specific conductance, and temperature of water samples. The use, calibration, and care of these meters will be in accordance with the Manufacturer's recommendations.

The groundwater sample will be taken as soon as the well is adequately purged. If the well was pumped dry during purging, the sample will be obtained as soon as adequate formation water is present in the casing. The sampler will record the following sampling data on a field sampling sheet:

- Identification of the well;
- Well depth;

- Static water level depth and measurement techniques;
- Well yield;
- Purge volume, pumping rate and volume per casing volume;
- Time well purged;
- Collection methods (bail or pump);
- Field observations (such as well condition, sample color, sample smell, sound);
- Name of collector; and
- Climatic conditions, including air temperature.

Once a water sample has been taken, the quality of the sample may degrade with time. As a result, all samples will be kept cool and some must be preserved in order to lengthen the acceptable holding time. The contract laboratory will be consulted when determining proper preservation techniques for samples that require off-site analysis. Samples to be analyzed for dissolved metals will be filtered using a 0.45 micron filter to remove suspended solids that may affect the results.

Preservative (acid) will be added to sample containers either before or immediately after collection and filtration, if required, of samples. Table 5-2 provides a summary of the sampling and preservation recommendations for analytes typically of concern in groundwater. Field sampling personnel will consult the bottle and preservation list provided by the contract laboratory to ensure that the appropriate sample preservation method is used.

Table 5-2 Sampling and Preservation Recommendations

Parameter	Volume Required (mls)	Preservative	Holding Time
Dissolved Metals	250	Filter (0.45 µm), then add HNO_3 to ph<2	6 months
Total Metals	250	HNO_3 to ph<2	6 months
Alkalinity	100	Cool, 4°C	14 days
Chloride	50	None Required	28 days
Conductance	100	Cool, 4°C	28 days
Fluoride	50	None Required	28 days
Ammonia as N	50	H_2SO_4 to pH<2, Cool, 4°C	28 days
Nitrate + Nitrite	50	H_2SO_4 to pH<2, Cool, 4°C	28 days
Nitrate	50	Cool, 4°C	48 hours
Nitrite	50	Cool, 4°C	48 hours
pH	25	None Required	Analyze immediately
TDS	500	Cool, 4°C	7 days
TSS	500	Cool, 4°C	7 days
Sulfate	100	Cool, 4°C	28 days
Lead-210	1000	HNO_3 to ph<2	6 months
Polonium-210	1000	HNO_3 to ph<2	6 months
Radium-226	1000	HNO_3 to ph<2	6 months
Uranium	1000	HNO_3 to ph<2	6 months

Chain of Custody (COC) forms will accompany every sample sent to off-site contract laboratories. The sampler will document on the COC form, at a minimum, the type of sample, the sample identification number, the preservation techniques (if any), the name of the sampler, the date and time the sample was taken, the name(s) of individuals who handled the sample and when they passed it on to another person, and the required analysis.

5.7.8.2.3 Monitor Well Baseline Water Quality

Monitor well ring wells are installed within the production zone, outside the mineralized portion of the production zone and production pattern area in a "ring" around the mine area. These wells are used to obtain baseline water quality data and characterize the area outside the production pattern area. Upper Control Limits (UCLs) are determined for these wells from the baseline water quality data for use during operational excursion monitoring. As described in Section 3, the distance between these monitor wells will be no more than 500 feet and the distance between these monitor wells and the production patterns will be approximately 500 feet.

Monitor wells will be installed within the overlying aquifer and underlying aquifer at a density of one well per every four acres of pattern area. These wells will be used to obtain baseline water quality data to be used in the development of UCLs for these zones.

After completion, wells will be developed (by air flushing or pumping) until water quality in terms of pH and specific conductivity appears to be stable and consistent with the anticipated water quality of the area. After development, wells will be sampled to obtain baseline water quality. Wells will be purged before sample collection to ensure that representative water is obtained. All monitor wells including ore zone and overlying and underlying monitor wells will be sampled four times at least two weeks apart. The first sample will be analyzed for the Guideline 8 parameters shown in Table 5-3. Subsequent samples will be analyzed for the Assay Suite B analytes approved in SUA-1341 (i.e., Total Dissolved Solids, sulfate, chloride, conductivity, total alkalinity, pH, arsenic, selenium, natural uranium, and Ra-226). Results from the samples will be averaged arithmetically to obtain a baseline mean value determination of upper control limits for excursion detection. If the data collected for the monitor well ring unit indicate that waters of different underground water classes (WDEQ-WQD Rules and Regulations, Chapter VIII) exist together, the data are not averaged together, but treated as sub-zones. Data within specific sub-zones are averaged. Boundaries of sub-zones, where required, are delineated at half-way between the sets of sampled wells which define the sub-zones.

Table 5-3 Baseline Water Quality Parameters WDEQ LQD Guideline 8

Constituents (reported in mg/l unless noted)	Analytical Method
Ammonia Nitrogen as N	*EPA 350.1*
Nitrate + Nitrite as N	*EPA 353.2*
Bicarbonate	*EPA 310.1/310.2*
Boron	*EPA 212.3/200.7*
Carbonate	*EPA 310.1/310.2*
Fluoride	*EPA 340.1/340.2/340.3*
Sulfate	*EPA 375.1/375.2*
Total Dissolved Solids (TDS) @ 180°F	*EPA 160.1/SM2540C*
Dissolved Arsenic	*EPA 206.3/200.9/200.8*
Dissolved Cadmium	*EPA 200.9/200.7/200.8*
Dissolved Calcium	*EPA 200.7/215.1/215.2*
Dissolved Chloride	*EPA 300.0*
Dissolved Chromium	*EPA 200.9/200.7/200.8*
Total and Dissolved Iron	*EPA 236.1/200.9/200.7/200.8*
Dissolved Magnesium	*EPA 200.7/242.1*
Total Manganese	*EPA 200.9/200.7/200.8/243.1/243.2*
Dissolved Molybdenum	*EPA 200.7/200.8*
Dissolved Potassium	*EPA 200.7/258.1*
Dissolved Selenium	*EPA 270.3/200.9/200.8*
Dissolved Sodium	*EPA 200.7/273.1*
Dissolved Zinc	*EPA 200.9/200.7/200.8*
Radium-226 (pCi/l)	*DOE RP450/EPA 903.1/SM 7500-R-AD*
Radium-228 (pCi/l)	*SM 7500-R-AD*
Gross Alpha (pCi/l)	*DOE RP710/CHEMTA-GP B1/EPA 900*
Gross Beta (pCi/l)	*DOE RP710/CHEMTA-GP B1/EPA 900*
Uranium	*DOE MM 800/EPA 200.8*
Vanadium	*EPA 286.1/286.2/200.7/200.8*

5.7.8.2.4 Wellfield Hydrologic Data Package

Following completion of the field data collection, the Wellfield Hydrologic Data Package is assembled and submitted to the WDEQ for review. In accordance with NRC Performance-Based Licensing requirements, the Wellfield Hydrologic Data Package is reviewed by a SERP to ensure that the results of the hydrologic testing and the planned mining activities are consistent with technical requirements and do not conflict with any requirement stated in NRC regulations or in the NRC license. A written SERP evaluation will evaluate safety and environmental concerns and demonstrate compliance with applicable NRC license requirements as previously discussed in Section **Error! Reference source not found.**. The written SERP evaluation will be maintained at the site.

The Wellfield Hydrologic Data Package contains the following:

1. A description of the proposed mine unit (location, extent, etc.);
2. A map(s) showing the proposed production patterns and locations of all monitor wells;
3. Geologic cross-sections and cross-section location maps;
4. Isopach maps of the Production Zone sand, overlying confining unit and underlying confining unit;
5. Discussion of how the hydrologic test was performed, including well completion reports;
6. Discussion of the results and conclusions of the hydrologic test including pump test raw data, drawdown match curves, potentiometric surface maps, water level graphs, drawdown maps and when appropriate, directional transmissivity data and graphs;
7. Sufficient information to show that wells in the monitor well ring are in adequate communication with the production patterns;
8. Baseline water quality information including proposed Upper Control Limits (UCLs) for monitor wells and average Production Zone/Restoration Target Values; and
9. Any other information pertinent to the area tested will be included and discussed.

5.7.8.2.5 Operational Upper Control Limits and Excursion Monitoring

After baseline water quality is established for the monitor wells for a particular production unit, UCLs are set for chemical constituents that would be indicative of a migration of lixiviant from the well field. The constituents chosen for indicators of lixiviant migration for the proposed Ludeman Project and for which UCLs will be set are

chloride, conductivity, and total alkalinity. Chloride was chosen due to its low natural levels in the native groundwater and because chloride is introduced into the lixiviant from the IX process (uranium is exchanged for chloride on the ion exchange resin). Chloride is also a very mobile constituent in the groundwater and will show up very quickly in the case of a lixiviant migration to a monitor well. Conductivity was chosen because it is an excellent general indicator of overall groundwater quality. Total alkalinity concentrations could be affected during an excursion because bicarbonate is the major constituent added to the lixiviant during mining. Although groundwater levels are obtained and recorded prior to each well sampling, they are not used as an excursion indicator. UCLs will be set for each stratigraphic monitor zone (i.e., for the perimeter Production Zone, overlying and underlying aquifers). Before the upper control limit is calculated, outliers will be removed from the data set by using visual screening and the tolerance limit method discussed above. Any data point which does not fall within the tolerance limits set by the test will be considered suspect and will be eliminated for use in upper control limit calculation if no explanation can be found for the anomalous value. If all four baseline sample results from an individual well would be eliminated by the tolerance limit process, the well will have its own set of UCLs established based upon the average results of the four samples.

UCLs will be set at the baseline mean concentration plus five standard deviations for conductivity and total alkalinity The UCL for choride will be determined by adding 15 mg/l to the baseline mean if that value is greater than the baseline mean plus five standard deviations.

Operational monitoring consists of sampling the monitor wells at least twice monthly, at least ten days apart, and analyzing the samples for the excursion indicators chloride, conductivity and total alkalinity. Uranium One requests that in the event of certain situations such as inclement weather, mechanical failure, or other factors that may result in placing an employee at risk or potentially damaging the surrounding environment, NRC allow a delay in sampling of no more than five days. In these situations, Uranium One will document the cause and the duration of any delays.

Water level and analytical monitoring data for the UCL parameters are reported to the WDEQ-LQD on a quarterly basis. This data is retained on site for review by the NRC.

5.7.8.2.6 Excursion Verification and Corrective Action

During routine sampling, if two of the three UCL values for excursion indicators are exceeded in a monitor well, or if one UCL value is exceeded by 20%, the well will be re-sampled within 48 hours and analyzed for the excursion indicators. If the second sample does not exceed the UCLs, a third sample will be taken within 48 hours. If neither the second nor third sample results exceeded the UCLs, the first analysis is considered in

error. If the second or third sample verifies an exceedance, the well in question will be placed on excursion status. Upon verification of the excursion, the NRC Project Manager will be notified by telephone or email within 24 hours and notified in writing within 7 days. A written report describing the excursion event, corrective actions, and corrective action results will be submitted to the NRC within 60 days of the excursion confirmation. If wells are still on excursion status when the report is submitted, the report will also contain a schedule for submittal of future reports describing the excursion event, corrective actions taken, and results obtained. In the case of a vertical excursion to an overlying or underlying aquifer, the report will contain a projected date when characterization of the extent of the vertical excursion would be completed. If an excursion is verified, the following methods of corrective action will be instituted depending upon the circumstances:

- A preliminary investigation is completed to determine the probable cause;
- Adjustment of production and/or injection rates in the vicinity of the monitor well to increase the net over-recovery, thus inducing a hydraulic gradient toward the production zone;
- Pumping of individual wells to enhance solution recovery; and
- Injection into the wellfield area adjacent to the monitor well may be suspended. Recovery operations would continue, thus increasing the overall bleed rate and the recovery of wellfield solutions.

In addition to the above corrective actions, the monitor well on excursion status would be sampled weekly. Uranium and pH will be added to the routine analytical list of chloride, conductivity and total alkalinity. An excursion will be considered concluded when the concentrations of excursion indicators do not exceed the criteria defining an excursion for three consecutive one-week samples..

If an excursion is not corrected within 60 days of confirmation, injection of lixiviant into the wellfield will be terminated until the excursion is controlled, or the reclamation surety will be increased an amount that is agreeable to the NRC, which would cover the expected full cost of correcting and cleaning up the excursion. The surety increase would remain in force until the excursion is controlled. The written 60-day report would explain and justify the course of corrective action that be followed.

5.7.8.2.7 Surface Water Monitoring

Pre-operational surface water quality monitoring was performed as discussed in Sections 2.7 and 2.9. The proposed project area includes both perennial and ephemeral drainages as well as stock and irrigation ponds. Upstream and downstream samples from all pre-operational surface water locations will be obtained quarterly when water is present.

Surface water samples are collected using methods similar to groundwater. Samples are collected in the appropriate container(s) and field measurements for pH and conductivity are performed and documented using the techniques described in groundwater sampling methods. The sample bottle must be rinsed with the sample water. The bottle is then filled with the mouth of the sample bottle pointed downstream to prevent collecting debris. If samples involve analysis that requires filtration, collect water in a clean bucket for transfer to the filter apparatus. Treatment of sample containers, preservation techniques, holding times, and shipping techniques are identical to those used for groundwater samples previously described.

Surface water samples will be analyzed for Pb-210, Ra-226, Th-230, Unat, and Po-210. Surface water monitoring results will be submitted in the semi-annual environmental and effluent reports submitted to NRC.

5.7.9 Surge Pond Leak Detection Monitoring

Two small wastewater surge ponds are planned for each Satellite as discussed in Section 4. During operations, the leak detection standpipes will be checked for evidence of leakage on a weekly frequency. Visual inspection of the pond embankments, fences and liners and the measurement of pond freeboard will be performed on the same frequency. Anytime six (6) inches or more of fluid is detected in a leak detection system standpipe, a sample of the solution will be obtained and analyzed for chloride, conductivity, pH and uranium.10 CFR § 40.65 Should the analyses indicate that the surge pond is leaking (by comparison to chemical analyses of pond water), the following actions will be taken:

- The WDEQ and USNRC will be notified by telephone within 48 hours of leak verification;
- The level of the leaking pond will be lowered by transferring its contents into the adjacent surge pond. While lowering the water level in the pond, inspections of the liner will be made to determine the cause and location of the leakage. The area of investigation first centers around the pond area specific for the particular standpipe which contains fluid. Each lined surge pond will have six leak detection standpipes. Therefore, the area of leakage will be readily identifiable;
- Once the source of the leakage is found, the liner will be repaired and water will be reintroduced to the pond to check the adequacy of the repair. Water in the leak detection standpipes will be monitored on a daily basis while refilling the pond; and
- A written report will be submitted to the WDEQ and USNRC within 30 days of correcting the leakage. The report will include analytical data and will describe the cause of the leakage, corrective actions taken and the results of those actions.

5.7.10 Wildlife Monitoring

Annual wildlife monitoring surveys for the proposed project will be performed and will follow the same regimen as other ISR operations in the region to maximize comparisons among survey results and impact assessments. At a minimum, those surveys typically will include the following, as modified for site-specific habitats (e.g., no trees, so no bald eagle winter roost surveys):

1. Early spring surveys for new and/or occupied raptor territories and/or nests, monitoring of new sage-grouse leks within one mile of the license area and T&E species on and within the license area; and
2. Other surveys as required by regulating agencies.

Based on results from previous surveys, the WGFD recommended in late 1999 that big game monitoring be discontinued on all existing surface mine sites in Wyoming. Similarly, results from a three-year big game monitoring program conducted at the nearby Smith Ranch and Highland Uranium Projects during their respective permitting processes documented that those operations were having no significant negative impact on pronghorn or mule deer.

5.7.11 Quality Assurance Program

A Quality Assurance (QA) program will be implemented at the proposed Ludeman Project consistent with the recommendations contained in NRC Regulatory Guide 4.14 Sections 3 and 6 and Regulatory Guide 4.15 (NRC 1979). The purpose of the program will be to identify any deficiencies in the sampling techniques and measurement processes so that corrective action can be taken and to obtain a level of confidence in the results of the monitoring programs. The QA program will provide assurance to the regulatory agencies and the public that the monitoring results are valid.

The QA program addresses the following:

- Formal delineation of organizational structure and management responsibilities. Responsibility for both review/approval of written procedures and monitoring data/reports will be provided;
- Minimum qualifications and training programs for individuals performing radiological monitoring and those individuals associated with the QA program;
- Written procedures for QA activities. These procedures will include activities involving sample analysis, calibration of instrumentation, calculation techniques, data evaluation, and data reporting;

- Quality control (QC) in the laboratory, procedures cover statistical data evaluation, instrument calibration, duplicate sample programs and spike sample programs, outside laboratory QA/QC programs are included; and
- Provisions for periodic management audits to verify that the QA program is effectively implemented, to verify compliance with applicable rules, regulations and license requirements, and to protect employees by maintaining effluent releases and exposures ALARA.

QA procedures as described in RG 4.14, Sections 5 through 7, will be defined to ensure the quality of samples, that lower limits of detection consistent with requirements have been established, for sample and measurement precision and accuracy, and for recording and reporting of results. QA procedures will include:

1. Environmental monitoring procedures;
2. Testing procedures;
3. Exposure procedures;
4. Equipment operation and maintenance procedures;
5. Employee health and safety procedures; and
6. Incident response procedures.

The QA program will be audited periodically. The audits will be conducted by individuals qualified in radiochemistry and monitoring techniques. However, the auditors will not have direct responsibilities in the areas being audited. An example of an appropriate auditor is an outside consultant. The results of the audits will be documented and provided to the NRC and made available to members of management with authority to enact any changes needed.

5.8 REFERENCES

Brown, S. 1982, *Radiological Aspects of Uranium Solution Mining*, In: Uranium, 1, 1982, p. 37-52, Elsevier Scientific Publishing Co.

Brown, S, 2007, *Radiological Aspects of In Situ Uranium Recovery.* American Society of Mechanical Engineers, Proceedings of 11th International Conference on Environmental Management, Bruges, Belgium, September; ASME Press, New York, NY, ISBN 0-7918-3818-8

USNRC Regulatory Guide 8.31, *Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable* (Revision 1, May 2002).

USNRC Regulatory Guide 8.29, *Instructions Concerning Risks From Occupational Radiation Exposure* (Revision 1, February 1996).

USNRC Regulatory Guide 8.13, *Instruction Concerning Prenatal Radiation Exposure* (Revision 3, June 1999).

USNRC Regulatory Guide 3.56, *General Guidance For Designing, Testing, Operating, and Maintaining Emission Control Devices at Uranium Mills* (May 1986).

USNRC Regulatory Guide 8.30, *Health Physics Surveys in Uranium Recovery Facilities* (Revision 1, May 2002).

USNRC Regulatory Guide 8.34, *Monitoring Criteria and Methods To Calculate Occupational Radiation Doses* (July 1992).

USNRC Regulatory Guide 8.15, *Acceptable Programs For Respiratory Protection* (Revision 1, October 1999).

USNRC Regulatory Guide 8.36, *Radiation Exposure to the Embryo/Fetus* (July 1992).

USNRC Regulatory Guide 8.22, *Bioassay at Uranium Mills* (Revision 1, August 1988).

USNRC Regulatory Guide 4.14, *Radiological Effluent and Environmental Monitoring at Uranium Mills* (Revision 1, April 1980).

ADDENDUM 5-A

WYOMING ISR OPERATIONS QUALITY ASSURANCE PLAN

Wyoming In Situ Recovery Projects Quality Assurance Plan

Prepared by
Uranium One
Casper, Wyoming

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1 INTRODUCTION

This Quality Assurance Plan is applicable to the environmental monitoring program implemented by Uranium One at Wyoming ISR sites. The plan provides the quality requirements for field collection of samples and the subsequent analysis of those samples at a laboratory.

2 QUALITY PLAN REVIEW, REVISION AND DISTRIBUTION

This Quality Assurance Plan will be reviewed by affected project managers in accordance with the company policy for controlled documents. Revisions will be made at the direction of the Manager of Environmental and Regulatory Affairs, Wyoming to reflect changes in work scope, organizational interfaces or new regulatory requirements. This plan will be reviewed annually to ensure the content is valid and applicable to monitoring activities. Revisions to this plan will require approvals at the same level as the original document. At a minimum, copies of this QA Plan shall be available to all affected employees and support organizations.

3 REGULATORY REQUIREMENTS

This Quality Assurance Plan is designed to incorporate quality assurance/quality control requirements and guidance the following regulatory references:

– USNRC Regulatory Guide 4.14, *Radiological Effluent and Environmental Monitoring at Uranium Mills*, Revision 1, April 1980.

– USNRC Regulatory Guide 4.15, *Quality Assurance for Radiological Monitoring Programs (Normal Operations) – Effluent Steams and the Environment*, Revision 1, February 1979.

4 ORGANIZATION

Administration of the environmental monitoring programs in Wyoming is assigned to the Manager of Environmental and Regulatory Affairs, Wyoming. The Manager may delegate the day-to-day implementation of the environmental monitoring program to other Uranium One employees or to outside contractors, but he may not delegate the ultimate responsibility. Such assignment shall be in writing.

Key positions within the Uranium One management system include:

Senior Vice President, ISR Operations – The Senior Vice President, ISR Operations has responsibility for overall management of Wyoming operations for Uranium One. The Senior Vice President, ISR Operations reports to the Executive Vice President, Uranium One.

General Manager, Wyoming Operations - The General Manager, Wyoming Operations is responsible for all uranium production activity at the project site. All site operations, maintenance, construction, environmental health and safety, and support groups report directly to the General Manager, Wyoming Operations. In addition to production activities, the General Manager, Wyoming Operations is also responsible for implementing any industrial and radiation safety and environmental protection programs associated with operations.

Manager of Environmental and Regulatory Affairs, Wyoming – The Manager of Environmental and Regulatory Affairs, Wyoming has responsibility for the overall management of the environmental monitoring programs for Uranium One. The Manager of Environmental and Regulatory Affairs, Wyoming reports to the Senior Vice President, ISR Operations.

Radiation Safety Officer – The Radiation Safety Officer has responsibility for the overall management of the radiation safety program and the environmental monitoring programs for Uranium One including implementation of QA Program requirements related to radiation safety and environmental programs. The Radiation Safety Officer reports to the General Manager, Wyoming Operations and will coordinate with the Manager of Environmental and Regulatory Affairs, Wyoming.

5 QUALITY OBJECTIVES

Environmental data for the Wyoming ISR sites, derived through long-term monitoring and data interpretation, will be of sufficient quantitative and qualitative value to determine whether performance criteria are being met. The type and quality of data provided to the appropriate regulatory agencies will be used to document the performance of the uranium recovery operation and later attainment of reclamation and restoration goals.

Monitoring strategy for sampling and analytical QA objectives for data include:

– Data will be of sufficient quality to withstand scientific and legal scrutiny.
– Data will be acquired in accordance with procedures appropriate for their intended use.
– Data will be of known accuracy and precision.
– Data will be complete, representative, and comparable.

5.1 FIELD QUALITY OBJECTIVES

The field and analytical methods chosen for use in completing the work are industry standards and are consistent with accepted standards for conducting environmental investigations.

5.2 LABORATORY QUALITY OBJECTIVES

The quality of data generated by the analytical laboratory is dependent on method precision, accuracy, and sensitivity and the basic nature of the analysis and type of equipment used to perform an analysis. Precision is a measure of the reproducibility of an analytical measurement, and accuracy is the difference between a measured value and a true or known value. These considerations are dependent upon the sample matrix and performance criteria, and method sensitivity may not be achieved in all sample matrices.

5.2.1 Precision

Precision is the agreement between a set of replicate measurements without assumption about or knowledge of the true value. Precision is assessed on the basis of repetitive measurements. Replicate field measurements of ground water are not needed because they are sequentially recorded during well purging. Evaluations will be performed to judge the precision of both field and laboratory measurement processes.

Duplicate sample analyses are used to monitor the overall precision that can be expected for a particular environmental medium within an analytical sample batch. Requirements for the collection frequency of QA samples will be specified in the site-specific environmental planning document sample events.

In the laboratory, precision is a measure of reproducibility and may be determined by repeated analysis of laboratory control samples (LCSs) or reference standards or by duplicate analysis. The laboratory will demonstrate precision through analysis of replicate standards and performance samples prior to analysis of investigative samples as required by the particular analytical method.

5.2.2 Bias

Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. The analytical laboratory will analyze reference materials to verify that the analytical results are not biased. Calibration and operational checks of field instruments will verify that no bias is present in field measurements.

5.2.3 Accuracy

Accuracy is the nearness of a measurement or the mean of a set of measurements, to the true value and is usually expressed as the difference between the two values or the difference as a percentage of true value.

It is not possible to directly assess accuracy of field measurements and water levels because true values for these measurements are not known. To ensure accuracy of the field data, instruments and equipment used in surveying, sampling, or obtaining the measurements will be maintained and calibrated. Accuracy of surface water and ground water field measurements is addressed indirectly through instrument checks and calibrations, which will be documented in field logbooks or on field data sheets, as appropriate.

Accuracy will be assessed for analytical data by examining the results obtained from laboratory Quality Control (QC) samples. The primary means of determining the accuracy of an analytical method is to compare the results of repeated measurements of laboratory control samples and reference material with published known values. The secondary method of accessing accuracy is to analyze matrix spike samples. Accuracy requirements of routine analytical services are specified in the analytical methods. Accuracy for each analysis will be stated as a percent recovery in laboratory analytical reports.

5.2.4 Representativeness

Representativeness is generally ensured through the use of standard sampling protocols. Representativeness will be accomplished:

- Through extensive sampling that includes implementation of field QA/QC procedures.
- By careful and informed selection of sampling sites, sampling depths, and analytical parameters
- Through the proper collection and handling of samples to avoid interferences and to minimize constituent loss
- By monitoring field activities to ensure procedure compliance and adherence to sampling protocols
- By meeting sample care and custody requirements

5.2.5 Comparability

Comparability is the confidence with which one data set can be compared to another. Comparability is ensured by employing approved sampling plans, standardized field procedures, and experienced personnel using properly maintained and calibrated instruments. In the laboratory, sample handling and preparation procedures, analytical procedures, holding times, and QA protocols will be adhered to. All data in a particular data set will be obtained by the same methods and will use consistent units for reportable data. Prescribed QC procedures will be used to provide results of known quality. Data will be grouped and evaluated according to similar sampling methods, sampling media, and laboratory analytical methods.

5.2.6 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the analyte of interest. An evaluation of sensitivity is included in the analytical methods that are used to analyze samples.

6 PERSONNEL AND TRAINING

6.1 PERSONNEL REQUIREMENTS

6.1.1 Training

Personnel will be qualified to perform their assigned job through meeting basic job description requirements, education standards, experience, and ongoing performance reviews. Training will be provided when needed to maintain proficiency; to adapt to new technologies, equipment, or instruments; and to perform new assigned responsibilities.

The RSO is responsible for determining site-required training and communicating the requirements to appropriate managers. Managers are responsible for determining training needs of their staff. Personnel assigned to environmental monitoring activities are responsible for ensuring that their required training are documented and are maintained in a current status for their assignments. At a minimum, individual training requirements will be reviewed annually and updated as needed.

The RSO is responsible for ensuring that personnel assigned to environmental monitoring tasks are sufficiently familiar with the implementing documents (e.g., plans, procedures,

and drawings) and the requirements established for environmental monitoring, sample collection, analysis, documenting and reporting activities, and demonstrating proficiency.

The RSO will ensure that personnel assigned to field sampling activities can demonstrate proficiency when performing the work or that they are properly supervised by a person who is proficient.

6.1.2 Certifications

QA staff that performs independent assessments of environmental monitoring activities or management systems will be qualified as lead assessors.

Laboratories used for analysis of samples collected for characterization, compliance, or other purposes will be required to pass an audit or be certified by the National Environmental Laboratory Accreditation Conference (NELAC).

7 DATA GENERATION AND ACQUISITION

This section addresses aspects of the measurement system design and implementation to ensure that appropriate methods for sampling, analysis, data handling, and QC are employed and will be thoroughly documented.

7.1 SAMPLING PROCESS DESIGN

The data obtained through monitoring site conditions will be of sufficient quantity and quality to achieve environmental monitoring objectives.

Monitoring procedures for the Wyoming ISR sites have been established. These monitoring programs are designed to ensure that monitoring data would satisfy applicable regulations and would ensure that there were no unacceptable risks to human health or the environment. The site-specific environmental monitoring plan defines the sample locations and sampling frequency and determines the types of analyses that will be conducted on the samples collected from these locations. The plans are reviewed every 5 years. Any updates to the monitoring plan that would eliminate or modify monitoring parameters, locations, or frequencies specified in the License Application will be made by license amendment. The RSO can initiate changes to environmental monitoring plans that do not require a license amendment. These changes will be managed as required by the Performance Based License Condition.

7.2 SAMPLING METHODS

Field measurements and sample collection will follow procedures attached to nationally recognized consensus standards such as EPA methods, American Society for Testing and Materials standards, or instrument manufacturer recommended procedures. Deviation from approved procedures requires approval by the RSO before the start of work.

7.2.1 Sample Collection Procedures

Sampling procedures used at Wyoming ISR sites will be managed as controlled documents and will be amended according to the requirements of this plan.

Procedures must be followed for documenting field activities and delivering the samples to the laboratory. Procedures will identify the methods employed to obtain representative field measurements and samples of specified media. The procedures will identify the equipment, instruments, and sampling tools that are needed and, where appropriate, performance criteria (e.g., special handling, operational checks, field calibrations) to ensure the quality of the field data.

The RSO is responsible for ensuring that inspections, operations and maintenance activities, field measurements, and specified samples are properly documented, occur at the prescribed frequency and locations, and are obtained in compliance with procedures and requirements specified in the project documents. Daily QC checks and data reviews will ensure that requirements have been met. If field conditions prevent inspections, required field measurements, and/or specified sample collection, the conditions will be fully documented in the field book as a field variance.

7.2.2 Field Measurements and Sampling Methods

Field measurements and sampling schedules are summarized in the environmental monitoring procedures. The data obtained through these activities will be used to monitor compliance with performance requirements. Field procedures used in well inspections, field measurements, sample collection methods, field data, equipment and supplies applicable to the field activities, sample preservation requirements, and QC sample requirements are described in the environmental monitoring procedures.

7.3 PREPARATION AND DECONTAMINATION REQUIREMENTS FOR SAMPLING EQUIPMENT

7.3.1 Requirements for Sample Containers, Preservation, and Holding Times

Nondedicated equipment used in obtaining samples will be visually inspected and cleaned before use at each sample location. Measures will be taken (e.g., storage in trays, plastic bags, or boxes) to protect clean or decontaminated equipment while it is not being used. Sample containers will be inspected for integrity and cleanliness before being used. Suspect containers will be discarded in a manner that will preclude their inadvertent use, or they will be tagged and segregated for return to the supplier.

7.3.2 Container Requirements

Sample containers will be will be provided by the analytical laboratory or purchased. Containers will be of an adequate size to contain the required sample volume and of an approved material (e.g., amber/clear glass or HDPE) that does not promote sample degradation. As appropriate, supplier provided certificates of cleanliness will be retained with the project documentation.

7.3.3 Preservation and Holding Times

Efforts to preserve the integrity of the samples through prescribed chemical additives and/or temperature-controlled storage will be maintained as appropriate from the time the containers are received, throughout the sample collection and shipping process, and will continue until all analyses are performed. Procedures that will be employed to collect and preserve the integrity of the samples are described in the procedures. Holding times begin at the time the sample is collected, not when the sample is received by the laboratory.

7.3.4 Decontamination Procedures and Materials

Where practical, dedicated pumps will be installed in monitor wells and disposable materials will be used to minimize the decontamination requirements. The final rinse following equipment decontamination will be collected as an equipment blank QC sample.

7.4 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

Sample handling, custody, and shipping procedures are addressed in the environmental monitoring procedures. A minimum number of individuals should be involved in sample collection and handling to ensure integrity of the sample and compliance with custody

procedures. To maintain evidence of authenticity, the samples collected must be properly identified and easily discernable from like samples. To maintain the integrity of the sample, proper preservation, storage, and shipping methods will be used.

Unused sampling equipment, sample containers, and coolers that have been shipped or transported to a sampling location will be kept in a clean, temperature-controlled, and secure location to minimize damage, tampering, degradation, and possible cross-contamination.

7.4.1 Identification, Handling, Packaging, and Storage

7.4.1.1 Sample Identification

Environmental samples and associated QC samples will be assigned a unique identification number. In addition to the unique number, QC samples will be assigned a fictitious location identifier that is consistent with the sample location identification scheme.

Samples will be identified by a label or tag attached to the sample container that specifies, as appropriate, the project, sample location, unique identification number, preservatives added, date and time collected, and the sampler's name. Sample labels, tags, and/or container markings should be completed with indelible (waterproof) ink. Clear tape may be placed over each sample label for added protection, if needed.

7.4.1.2 Sample Handling and Storage

During field collection, sample containers may be stored in boxes, trays, or coolers, as dictated by protection and preservation needs. Samples that require refrigeration will be stored in coolers with sufficient ice to maintain the required temperature controls during field collection, packaging, and shipping. Samples that are not transported to the laboratory the day of collection must be stored in containers that will prevent damage or degradation of the sample. In addition, samples must be stored in locked containers or buildings when they are out of the direct control of the responsible custodian. Samples stored overnight or at locations where access is not solely controlled by the custodian will have custody seals placed on the outside of the container (cooler or box) as a measure of security.

7.4.1.3 Sample Custody

To ensure the integrity of the sample, the field custodian is responsible for the care, packaging, and custody of the samples until they are transferred to the laboratory.

Chain of Custody forms will be used to list all samples and transfers of sample possession to provide documentation that the samples were in constant custody between collection and analysis. The filled-in Chain of Sample Custody form, a copy of which is retained by the originator, will accompany samples that are sent or transported to the analytical laboratory.

7.4.1.4 Sample Packaging and Shipping

All samples will be handled, packaged, and transported or shipped in accordance with applicable U.S. Department of Transportation requirements. Sample storage containers (e.g., boxes or coolers) and sample containers will be securely packaged to protect the contents from damage, spilling, leaking, or breaking. Void space in shipping containers should be filled with an inert material or additional ice, if appropriate, to further protect and secure the contents.

Custody seals are not required for containers or samples that are transported directly to the analytical laboratory for analysis or interim storage. Custody seals are required for shipping containers (e.g., coolers or boxes) that are sent by common carrier. Clear tape should be placed over the seals as protection against tearing during shipment.

Mailed sample packages will be registered with return receipt requested. If packages are sent by common carrier, receipts are retained as part of the chain of custody documentation. Other commercial carrier documents shall be maintained with the chain of custody records.

7.4.2 Laboratory Requirements

7.4.2.1 Laboratory Sample Receipt

The subcontract analytical laboratory personnel are responsible for the care and custody of samples from the time they are received until the time the sample is analyzed and archive portions are discarded. On arrival at the laboratory, laboratory personnel must examine the container and document the receiving condition, including the integrity of custody seals, when applicable. When opening the shipping container, laboratory personnel will examine the contents and record the condition of the individual sample containers (e.g., bottles broken or leaking), the temperature (when applicable), method of shipment, carrier name(s), and other information relevant to sample receipt and log-in. Laboratory personnel verify that the information on the sample containers matches the information on the Chain of Sample Custody form.

7.4.2.2 Discrepancies Identified During Sample Receipt

If discrepancies are identified during the sample receiving process, laboratory personnel will attempt to resolve the problem by checking all available information (e.g., other markings on sample containers and type of sample), recording appropriate notes on the Chain of Sample Custody form, and contacting the RSO to resolve any questions.

If the laboratory judges the sample integrity to be questionable (e.g., samples arrive damaged or leaking, or the temperature range is exceeded), the RSO will be contacted and will bring in appropriate technical staff to make a decision regarding rejecting or flagging the data and/or re-sampling the location. Damaged samples will be rescheduled for collection and analysis, if necessary.

Discrepancies noted during sample receiving at a subcontracted laboratory or testing facility will be resolved in accordance with the procurement documents. In general, the RSO will be contacted to facilitate resolution of a problem.

7.4.2.3 Sample Disposition

When sample analyses and necessary QA/QC checks have been completed in the laboratory, the residual sample material and wastes generated as a result of the analytical process will be treated, shipped, and disposed of in accordance with all applicable federal, state, and local transportation and waste management requirements. When samples are stored, they will be protected to prevent damage or degradation. At a minimum, samples shall not be removed from the laboratory sooner than 60 days after the delivery of laboratory data reports.

7.4.3 Analytical Methods

Laboratories involved in the analysis of samples will have a written QA/QC program that provides rules and guidelines to ensure reliability and validity of the work conducted at the laboratory.

The analytical procedures to be used by subcontracted laboratory services will be specified in the procurement documents. These procedures typically consist of EPA methods. The use of these methods will ensure that required method detection limits and project reporting limits are achieved for each of the requested analytes.

Required analytical methods will be documented in appropriate site-specific documents.

7.4.3.1 Subcontracted Laboratory Requirements

The subcontracted laboratory will have a documented QA program in place, the implementation of which may be independently verified through proposal reviews, prior history, and/or pre-award survey. As appropriate, subcontracted laboratories will use EPA or EPA-approved methods or other methods specified and approved within the provisions of the procurement documents. Subcontracted laboratories are required to pass an audit or be certified by NELAC. Internal method requirements for analysis of spikes, duplicates, or replicates will be followed and may be used as performance indicators for these services.

Data turnaround times, sample disposition, and other requirements of the analytical laboratory are identified in procurement documents. The laboratory must obtain authorization from the RSO for changes to the procurement documents.

Work submitted to the laboratory may not be subcontracted by the laboratory without the prior consent of Uranium One.

7.4.4 Quality Assurance/Quality Control

7.4.4.1 Field QA/QC

A variety of instruments, equipment, sampling tools, and supplies will be used to collect samples and to monitor site conditions. Proper inspection, calibration, maintenance, and use of the instruments and equipment are required to ensure field data quality. In addition, field QA will be implemented through the use of approved procedures, proper cleaning and decontamination, protective storage of equipment and supplies, and timely data reviews during field activities. The QC objective of these data collection activities is to obtain reproducible and comparable measurements to a degree of accuracy consistent with the intended use of the data.

QC samples will consist of field duplicates, equipment rinsate blanks, and trip blanks, as appropriate, for the matrix and analytes involved. An additional volume of ground water for selected analyses will be collected for matrix spike/matrix spike duplicate (MS/MSD) use, as requested by the laboratory. Field QC samples will be used to quantitatively and qualitatively evaluate the analytical performance of the laboratory and to assess external and internal effects on the accuracy and comparability of the reported results. Field QC samples will be uniquely identified.

Where applicable, field measurement data will be compared to previous measurements obtained at the same location. Large variations (greater than 30 percent) in field measurement data at a location will be examined to evaluate whether general trends are

developing. Variations in data that cannot be explained will be assigned a lower level of confidence through assignment of qualifiers or will be flagged for additional sampling or evaluation.

7.4.4.2 Laboratory QA/QC

Laboratory QC checks are internal system checks and control samples introduced by the laboratory into the sample analysis stream. These checks are used to validate data and calculate the accuracy and precision of the data. The objectives of the laboratory QA/QC program should be to:

- Ensure that procedures and any revisions are documented
- Ensure that analytical procedures are conducted according to sound scientific principals and have been validated
- Monitor the performance of the laboratory by a systematic inspection program and provide for corrective measures, as necessary.
- Collaborate with other laboratories in establishing quality levels, as appropriate
- Ensure that data are properly recorded and archived

Internal QA procedures for analytical services will be implemented by the laboratory in accordance with the laboratory's standard operating procedures. Data sheets, which also report the blank and spiked sample checks that have been performed, will be provided and will indicate when a QC check was performed. Analytical data that do not meet acceptance criteria will be qualified and flagged in accordance with standard operating procedures.

Laboratory quality control procedures are defined within the particular analytical method or are defined in procurement documents.

7.4.5 Instrument/Equipment Testing, Inspection, Calibration, and Maintenance

A variety of equipment, instruments, and sampling tools will be used to collect data and samples for the Wyoming ISR sites. Proper maintenance, calibration, and use of equipment and instruments are imperative to ensure the quality of all the data that are collected.

Field and laboratory equipment, instruments, tools, gauges, and other items used in performing work tasks that require preventive maintenance will be serviced in accordance with manufacturers' recommendations and instructions. When applicable, technical procedures will identify the manufacturers' instructions and recommended

frequency for servicing the equipment. Preventive maintenance for calibrated measuring and test equipment will be performed either by field or laboratory personnel who are knowledgeable of the equipment, or by manufacturer's authorized service center as part of routine calibration tasks. Records of equipment calibration, repair, or replacement of controlled instruments will be filed and maintained in accordance with the applicable records management requirements.

Instruments that are not calibrated to the manufacturers' specifications will display a warning tag to alert the sampler and analyst that the instrument has only limited calibration.

7.4.5.1 Field Equipment and Instruments

Field equipment, instruments, and associated supplies used to obtain field measurements and collect samples are specified in sampling procedures.

Field personnel will conduct visual inspections and operational checks of field equipment and instruments before they are shipped or carried to the field and before using the equipment or instruments in field data collection activities. Whenever any equipment, instrument, or tool is found to be defective or fails to meet project requirements, it will not be used, and as appropriate, it will be tagged defective and segregated to prevent inadvertent use. Backup equipment, instruments, and tools should be available on site or within 1-day shipment to avoid delays in the field schedule.

The RSO or designee is responsible for the overall maintenance, operation, calibration, and repairs made to field equipment, instruments, and tools. The RSO or designee is also responsible for ensuring that the field book has adequate documentation that describes any maintenance, repairs, and calibrations performed in the field.

Equipment and instruments used to obtain data will be maintained and calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturers' specifications. Calibration of equipment and instruments will be performed at approved intervals, as specified by the manufacturer, or more frequently as conditions dictate. Calibration standards used as reference standards will be traceable to the National Institute of Standards and Technology or other recognized standards when available. Instruments found to be out of tolerance will be tagged defective and segregated to prevent inadvertent use.

In some instances, calibration periods will be based on usage rather than periodic calibration. Equipment will be calibrated or checked as a part of its operational use. Records of field calibration will be documented on forms provided for technical

procedures or recorded in the field logbook. Calibration checks will be performed in accordance with procedures.

Procedures recommended by the manufacturer will be used for equipment preventive maintenance. Backup equipment, supplies, and critical spare parts (e.g., tape, bottles, filters, pH paper, tubing, probes, electrodes, and batteries) will be kept on site to minimize downtime. The RSO or designee is responsible for ensuring that routine maintenance is performed and that tools and spare parts used to conduct routine maintenance are available.

7.4.5.2 Laboratory Equipment and Instruments

As part of the QA/QC program for the analytical laboratory, routine preventive maintenance is conducted to minimize the occurrence of instrument failure and other system malfunctions. The laboratory will maintain a schedule for servicing critical items and will perform routine maintenance, scheduled maintenance and repair, or coordinate with a vendor to arrange for maintenance and repair service, as required. All laboratory instruments will be maintained in accordance with the manufacturers' specifications and the requirements of the specific method employed. Equipment will be tested during routine calibration, and deficiencies will be corrected as specified in procedures.

The concentration of standards and frequency of initial and continuing calibration of analytical instruments will be as specified in the laboratory procedures. Calibration data will be provided with the analytical data package. Calibration records pertaining to subcontracted laboratory services will be filed and maintained by the laboratory in accordance with internal procedures.

7.4.6 Instrument/Equipment Calibration and Frequency

Calibration of analytical laboratory equipment will be based on approved written procedures. The concentration of standards and frequency of initial and continuing calibration of analytical instruments will be as specified in the laboratory SOPs. The analytical laboratory will maintain calibration records. Calibration data will be provided with the analytical data package, as specified in the procurement documents.

7.4.7 Inspection/Acceptance of Supplies and Consumables

7.4.7.1 Sample Containers

Sample containers for water, soil, sediment, and other media will be provided by the subcontracted laboratory and will be new or pre-cleaned. As appropriate, supplier-provided certificates of cleanliness will be retained with field documentation.

Containers will be visually inspected for integrity and cleanliness before being used. Suspect containers will not be used and will be discarded in a controlled manner to prevent inadvertent future use. If sufficient quantities of containers are suspect, the laboratory will immediately be notified of the condition and requested to provide a sufficient quantity of replacement containers. Suspect containers will be collected, segregated, and tagged for return to the analytical laboratory. The RSO or designee will describe the situation in the field book as a field variance.

7.4.7.2 Supplies and Consumables

The RSO or designee is responsible for ensuring that supplies, materials, and consumable items used during field activities are properly inspected for integrity, cleanliness, and compliance with specified tolerances and that they are appropriate to the activity. Items with a specified shelf life or expiration date will be labeled. Expired materials will not be used and will be properly disposed of or returned to the laboratory for disposal, as appropriate. Supplies, materials, and equipment will be inventoried at the conclusion of the sampling event in preparation for the next scheduled event.

7.4.8 Data Management

Project data are generated mainly from routine sampling of monitor wells, routine operations system sampling, and occasional soil sampling events. The RSO or designee is responsible for managing project data in compliance with Uranium One requirements.

Field data books are assembled for most sampling events. These books contain information such as sample location identification (ID), date, QA sample ID, well purge method, sampling method, and field measurements. These are completed at the time of sample collection.

Data from samples submitted to an analytical laboratory are received as both hard copy and as electronic data. The hard copy analytical reports are archived in the project records along with the original field data forms and other relevant hard copy forms or documents containing project data. The hard copy forms are categorized in the project records according to the project filing procedures. Electronic data are also archived in the project records according to the project filing procedures.

7.5 DATA VALIDATION AND USABILITY

Technical data, including field data and results of laboratory analyses, will be routinely verified and validated to ensure that the data are of sufficient quality and quantity to meet the project's intended data needs. Results of data validation efforts will be documented and summarized in the site-specific validation reports. The person doing work is

responsible for initiating the review, verification, validation, and screening associated with field and/or laboratory data.

7.5.1 Field Measurement Data

The objective of field data verification is to ensure that data are collected in a consistent manner and in accordance with procedures and schedules established in the Wyoming ISR environmental planning documents. Field data validation procedures include a review of raw data and supporting documentation generated from field investigations. The data are reviewed for completeness, transcription errors, compliance with procedures, and accuracy of calculations.

The person doing the validation (in consultation with the RSO or designee, if required) may correct problems that are found or noted in field documentation. Corrections to data forms will be made by lining through the incorrect entry, correcting the information, then initialing and dating the corrected information. The person validating the document, with the consent of the RSO or designee, may also determine that incorrect data should not be entered into a database or that the data should have an additional qualifier.

7.5.2 Laboratory Data

The laboratory performing the analyses will document the analytical data in accordance with standard procedures inherent in the analytical methods and as approved by the RSO or designee, if required.

Once the data package is received from the analytical laboratory, laboratory records and data package requirements will be checked to assess the completeness of the data package, and the data will be validated by personnel qualified and experienced in laboratory data validation.

The QC data provided by the laboratory (method blanks, matrix spikes, etc.) will be evaluated to see if they are within the acceptance range. If they are not, the data set affected by the QC samples will be evaluated to determine if corrective action is necessary.

7.5.2.1 Quality Control Samples

QC samples consisting of trip blanks, equipment rinsate blanks, field duplicate samples (replicated or co-located samples), laboratory spikes, laboratory blanks, laboratory duplicates, and laboratory control samples (including thermoluminescent dosimeters) are evaluated in the data validation process.

7.5.3 Qualification of Data and Corrective Actions

Qualification criteria are defined in the Uranium One procedures. In addition to the process of qualifying the data, other corrective actions may be used. These may include reanalysis of the data by the laboratory or re-sampling of the affected locations. Other corrective actions to prevent contamination of future samples may also be proposed.

7.5.4 Determination of Anomalous Data

The final aspect of data validation involves the screening of both field and laboratory analytical data for potentially anomalous data points.

7.5.4.1 Data Screening

The initial step in determining potentially anomalous data points consists of screening all data from a sampling event for values that fall outside a designated historical data range. The historical data range used for comparison will be from previous sampling events.

7.5.4.2 Technical Review

The next step involves a review of the screened data by a qualified individual experienced in data review. Each data point will be evaluated to determine if the data point is acceptable or if follow-up action is required. This evaluation will consider factors such as number of historical data points, analyte concentration, magnitude of the deviation from the historical data range, number of historical non-detects, variability of the historical data, location of the sample point relative to other potential interfering activities, and correlation with other analytes.

7.5.4.3 Follow-up Actions

Follow-up actions can include one or more of the following:

- Requesting a laboratory check of calculations and dilutions
- Sample reanalysis
- Re-sampling
- Comparison to results from the next sampling event
- Data qualification

Based on the results of the follow-up action, the RSO will make a final determination of validity of the data point. The data point will be considered acceptable or it will be

qualified, and a record of the action will be made. A summary of any anomalous data will be included in the site-specific data validation report.

7.5.4.4 Data Qualification

After the RSO has determined that a data point is anomalous, the data point will be qualified as unusable in the database. Qualification of data will be noted with a brief justification for the qualification.

7.6 DOCUMENTATION AND RECORDS

The requirements for documentation and records management apply to the preparation, review, approval, issue, use, and revision of documents or forms that prescribe processes, specify requirements, or establish design. Records must be specified, prepared, reviewed, approved, and maintained as directed by Uranium One policy.

Field and laboratory data will be sufficiently documented to provide a scientifically defensible record of the activities and analyses performed. Records of field variance reports, internal reviews, field and laboratory records of tests and analyses, field logs, Chain of Custody forms, and project reports will be used in interpreting and assessing the usability of the data. Standardized forms and computer files, codes, programs, and printouts will be designed to eliminate errors made during data entry and reduction. Calculation steps are described in the technical and analytical procedures and software lists. Routine data-transfer and data-entry verification checks are performed.

7.6.1 Records Management Plan

A site-specific records management plan shall be prepared to identify the records to be generated, file locations, and retention schedule for the Wyoming ISR site. The records management plan establishes the requirements for preparing, preserving, and storing records. Project personnel will work with the RSO, or his designee, to ensure that environmental monitoring records are correctly identified and maintained in accordance with the plan. Modifications to the plan shall be submitted to the RSO and are subject to the RSO's review and approval. At a minimum the site record management plan will include the following requirements:

Records not utilized to determine occupational dose that require a 3 year retention period as specified in 10 CFR §20.2103:

- Area beta-gamma measurements and associated instrument calibrations not utilized to determine employee dose;
- Equipment release records and associated instrument calibrations

- Instrument daily function check records;
- Alpha contamination surveys eating areas; and
- Personnel contamination surveys frisking stations

Instructions for the proper maintenance, control, and retention of records will be developed and will be consistent with the requirements of 10 CFR 20 Subpart L and 10 CFR §40.61 (d) and (e). The following specific records will be permanently maintained and retained until license termination:

- Records of disposal of byproduct material on site through deep disposal wells as required in 10 CFR §20.2002 and transfers or disposal off site of source or byproduct material;
- Records of surveys, calibrations, personnel monitoring, and bioassays as required in 10 CFR §20.2103;
- Records containing information pertinent to decommissioning and reclamation such as descriptions of spills, excursions, contamination events etc. including the dates, locations, areas, or facilities affected, assessments of hazards, corrective and cleanup actions taken, and potential locations of inaccessible contamination;
- Records of information related to site and aquifer characterization and background radiation levels;
- As-build drawings and photographs of structures, equipment, restricted areas, well fields, areas where radioactive materials are stored, and any modifications showing the locations of these structures and systems; and
- Records of the radiation protection program including program revisions, standard operating procedures, radiation work permits, training and qualification records, SERP proceedings and audits.

The RSO will be responsible for ensuring that the required records are maintained and controlled. Hard copies of all records will be maintained on site in a controlled environment to protect them from damage deterioration and will be available for inspection by regulatory agencies. Electronic copies may be maintained in addition to hard copies with backup protection. Duplicates of all records will be maintained in the Casper office or other offsite location(s).

7.6.2 Document Control and Changes

Uranium One policy and procedures will be followed to ensure that the preparation, issuance, and revisions to project documents and forms will be controlled so that current and correct information is available at the work location. These project documents (e.g., plans, procedures, drawings, and forms) and subsequent revisions will be reviewed for adequacy and approved before being issued for use. Written records and photo

documentation will be handled in a manner that ensures association to the activity, the samples, and their locations. The RSO can authorize minor changes to project documents without requiring a formal review process.

At a minimum, personnel responsible for environmental monitoring activities at the Wyoming ISR site will have access to the applicable documents and will be knowledgeable of the contents before the associated work assignment.

Nonroutine sampling and field investigations will be documented in the file. The RSO will be briefed on and will approve all nonroutine field investigations before the work begins.

7.6.3 Corrections to Documents

When practical, correction of errors should be made by the individual who made the entry. The method used to make a correction is to draw a line through the error, enter the correct information, then initial and date the entry. The erroneous material must not be obscured.

When a document requires replacement due to illegibility or inaccuracies, the document will be voided, and a replacement document will be prepared. A notation will be made on the voided document that a replacement document was completed. The voided document will be retained with the field documentation.

7.6.4 Project Documents

Project documents are written materials that provide a background or history of the work, establish the basis for the work, give guidance to the work, and provide a summary of the work. They may be documents such as technical reports, technical and administrative plans, inspection or test documents, and design or as-built drawings. Documents prepared for the Wyoming ISR site that establishes instructions or procedures will be developed in accordance with the applicable requirements. Documents that are subject to revision will be managed and issued as controlled documents. These include, but are not limited to, the following documents:

- Quality Assurance Plans and Procedures
- Site-Specific Environmental Monitoring and Sampling Plans

7.6.5 Procedure Requirements

Uranium One personnel will comply with the requirements of all approved written procedures or other instructions. Any deviation from approved field procedures must be authorized by the RSO. Field changes to project plans or deviation from procedures will be documented in the field book as a field variance and communicated to the RSO as soon as possible.

The RSO will be notified of any changes to subcontract laboratory procedures. The RSO will be informed of and review changes to laboratory procedures. Impacts will be identified to the RSO. As appropriate, procedure changes that affect laboratory data will be identified and documented during the data review, verification, and validation activities. As appropriate, the RSO will inform Uranium One management of technical or other substantive changes to laboratory procedures that may affect reporting limits or analytical sensitivity.

7.6.6 Field Documentation

Field documentation requirements are specified in the sampling procedures. All entries in field documents will be made with indelible (waterproof) ink and will be legible, reproducible, accurate, complete, and traceable to the sample measurements and/or site location. These documents will be retained as project records. Field documents are intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the field sampling activities. Field logbooks and forms (e.g., sample collection data sheets, field measurement data forms, Chain of Custody forms, and shipping forms) will be stored in a manner that protects them from loss or damage.

The sampler will adequately document and identify field measurements and each sample collected. Field records will be completed at the time the observation or measurement is made and when the sample is collected. Project documents and written procedures will be available at the work site. The RSO or designee will ensure that specified requirements are followed so that an accurate record of sample collection and transfer activities is maintained.

As appropriate, sample disposition will be specified to the subcontract laboratory in the appropriate procurement documents.

7.6.6.1 Field Variance and Nonconformance Documentation

Changes from specified field protocols established in planning documents or standard operating procedures must be authorized by the RSO and fully documented by the person doing the sampling. Field variances will be reported in a timely manner to evaluate the impact the variance has on the data or system operations. Field variance reporting applies

to deviations from (1) prescribed field sampling and measurement requirements; (2) specified shipping, handling, or storage requirements; and (3) decontamination procedures.

A variance must be documented whenever an activity is performed or sample is obtained where:

- The activity performed or sample collection technique does not fall within the methods or protocols specified.
- The monitoring or measurement instrument that was used was out of calibration or had failed an operational check.
- Insufficient documentation results in the inability to trace the activity, measurement, or sample to the prescribed or selected location
- There is a loss of or damage to records that cannot be duplicated.

The variance should be fully described, and corrective action, if applicable, should be taken immediately. Comments describing the variance will be used during data evaluation to assess the use of associated results and validity of the data. Field variances should be noted in the field data sheet, on a general log sheet, or in the activity logbook. As appropriate, field variances will be summarized in the report at the conclusion of the activity.

7.6.6.2 Chain of Sample Custody

The custody of individual samples will be documented by recording each sample's identification, number of containers, and matrix on a standardized Chain of Custody form. This form will be used to list all transfers of sample possession.

7.6.7 Laboratory Documentation

The format and content of laboratory reports depend on contract requirements, regulatory reporting formats, and whether explanatory text is required. At a minimum, the laboratory data report will include the following items:

- Analytical method used
- Date and time of analysis
- The Chain of Custody form
- Sample receiving documentation
- QC data results and report

- Sample data results by analysis, including method detection limits, reporting limits, and dilution factors
- Summary of results (e.g., case narrative)
- Certification by the laboratory that the analytical data meet applicable data quality requirements

Analytical data that do not meet specified criteria will be qualified and flagged to allow data evaluation before use. Any nonconformances or difficulties encountered during analyses will be documented with each data package.

7.6.8 Reports Received from Subcontractors

7.6.8.1 Laboratory or Other Data Reports

Reporting requirements and formats will be defined in procurement documents issued for subcontracted services. The RSO will be consulted regarding difficulties or nonconformance associated with subcontracted analytical services and will resolve disputes that could affect data quality.

7.6.8.2 Plans and Technical Reports

The criteria for technical reports received from subcontracted services may include a deliverable schedule for draft and final documents, required reviews, format, software type and version requirements, and contents of the document, including any supporting documents, data, and references.

7.7 QUALITY IMPROVEMENT, ASSESSMENT, AND OVERSIGHT

All personnel must continually seek to improve the quality of their work. This section addresses the activities for assessing the effectiveness of the implementation of the project and associated QA/QC requirements.

7.7.1 Quality Improvement

Management encourages innovation and continuous improvement in the work environment by fostering a "no fault" attitude to encourage the identification of problems and to create an atmosphere of openness to suggestions for improvement. All personnel are encouraged to identify and suggest improvements.

Personnel have the freedom and authority to stop work until effective corrective action has been taken. Work that is performed by subcontractors will be subject to oversight. The work may be suspended immediately for imminent threats to health, safety, environmental release, or significant adverse quality issues. Re-start of such work stoppages will be at the direction of the General Manager, Wyoming Operations.

7.7.1.1 Corrective Actions

Corrective actions are the process of identifying, recommending, approving and implementing measures to improve unacceptable procedures, and sampling practices that may affect data quality. All proposed and implemented corrective actions will be documented through the site SERP process. Items requiring immediate corrective actions will be implemented with the approval of the Radiation Safety Office and modifications documented through the SERP process.

If corrective actions are insufficient, the appropriate personnel may issue suspension of work until the problem can be resolved.

During any field sampling activity, the field personnel will be responsible for documenting and reporting all QA nonconformance's and suspected deficiencies associated with the sampling being conducted. All nonconformance's and or deficiencies will be documented in the field log book or sheets and reported to the RSO. If the problem is associated with field measurement sampling equipment, the field personnel will take the appropriate corrective actions. If the field corrective actions are not sufficient to correct the deficiency, personnel may suspend field activities until the problem can be resolved. Any time field activities have been suspended due to QA deficiencies the RSO shall be notified.

Field corrective actions could include:

- Repeating the measurement to check for errors
- Checking, recharging or replacing batteries in sampling equipment
- Re-calibration or function check of instrument or equipment to ensure proper operations
- Replacing meter or instruments not functions properly

Field corrective actions will be documented.

7.7.2 Assessment and Response Actions

Assessments of project activities will be planned and scheduled with the appropriate levels of management. The Manager of Environmental and Regulatory Affairs - Wyoming is responsible for scheduling and administering the internal assessment plan.

When the assessment is conducted, results will be evaluated to measure the effectiveness of the implemented quality system. Assessment activities may include management assessments and independent assessments.

Assessment activities will be documented. Reports resulting from management assessments will be issued to the responsible manager and distributed internally to project management. Assessment activities involving subcontracted services will be coordinated with the appropriate levels of project management and will be documented.

The RSO will promptly define corrective actions and correct deficiencies identified through assessments. Corrective actions will be independently verified by staff not organizationally reporting to the RSO. Verification will be documented and retained in the assessment file.

7.7.2.1 Management Assessments

Included in the management assessments are human resource issues, operations issues, resource allocation, financial performance, financial controls, and quality control. The Senior Vice President, ISR Operations is responsible for ensuring that project staff supports these activities as delegated, that they observe firsthand the work in progress, communicate with those performing the work, identify potential or current problems, and identify good practices.

The Senior Vice President, ISR Operations shall determine the scope, schedule, and responsibilities for site-specific management assessment. All levels of management are responsible for responding to assessment findings and completing agreed-upon corrective actions.

7.7.2.2 Independent Assessments

Independent assessments (e.g., audits and surveillances) will be planned, performed, and documented in accordance with written instructions, procedures, or checklists.

Personnel who lead independent assessments (audits or surveillances) must be qualified, have reporting independence, and have access to the areas of inquiry. The Senior Vice President, ISR Operations or designee will track, report on the status, and verify closure of independent assessments and external assessment findings.

The Senior Vice President, ISR Operations is responsible for responding to assessment findings and ensuring that agreed-upon corrective actions are completed in a timely manner.

7.7.3 Reviews

Reviews are an integral component to the success of project activities. Reviews are conducted during planning and throughout the project to ensure that project objectives will be met. Reviews conducted at the project level may consist of:

- Management reviews—to ensure the adequacy of planning and availability of resources
- Administrative and technical reviews—typically include reviews of project documents to ensure that project objectives are clearly described and sufficiently planned, scheduled, and managed in accordance with project management strategies.
- Procurement Reviews—typically Uranium One policies and procedures that apply to purchasing goods and services. Subcontracted analytical laboratories are required to have a documented QA program. Laboratory capability may be evaluated through review of the QA program description or through pre-award survey or vendor audit activities. The results of the survey are documented and provided to the laboratory.
- Independent Peer Reviews—May be conducted to solicit input for the planned technical approach and data quality objectives of the project or task.
- Data Review—to ensure that the data collected and used for each activity of the project are of sufficient quality. The RSO will conduct data reviews as a quality measure to ensure the adequacy and completeness of field activities. In addition, data review, verification, and validation will be conducted after a sampling event. Analytical data will be reviewed and summarized in the laboratory report. The results will include an explanation of any laboratory problems and their possible effects on data quality.

7.7.4 Reports to Management

Management assessments, internal assessments, and external appraisal report findings are documented. The QA organization maintains the schedule and file for these reports that are typically issued to the responsible manager.

Quality improvement actions (e.g., planning, lessons learned, nonconformance reporting, tracking and follow-up, and reviews) will be documented and reported to management.

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6 GROUNDWATER QUALITY RESTORATION, SURFACE RECLAMATION, AND FACILITY DECOMMISSIONING

Throughout the proposed project life, a variety of restoration and reclamation activities will be implemented in order to return the affected areas to their pre-production use. The methods to achieve this objective for both the affected groundwater and the land surface are described in the following sections.

6.1 PLANS AND SCHEDULES FOR GROUNDWATER QUALITY RESTORATION

This section presents Uranium One's proposed method for developing Restoration Target Values (RTV) and AUCs proposed groundwater restoration plan. Uranium One will conduct groundwater restoration operations concurrently with ISR production operations: as each wellfield recovery phase terminates, groundwater restoration will commence, even while other wellfields are still in recovery.

The proposed groundwater restoration process will begin following the permanent cessation of lixiviant injection, continuing through active restoration and post-restoration stability monitoring, and conclude with NRC and WDEQ/LQD approval of successful restoration for each wellfield.

6.1.1 Groundwater Restoration Criteria

The purpose of groundwater restoration is to protect groundwater adjacent to the mining zone. Approval of an aquifer exemption by the WDEQ and the EPA is required before mining operations can begin. The aquifer exemption removes the mining zone from protection under the Safe Drinking Water Act (SDWA). Agency approval of an exemption of a portion of an aquifer is based on existing water quality, the ability of the geologic formation hosting the aquifer to commercially produce minerals, and the inability to use (as a result of natural groundwater quality) or the lack of use of an aquifer as an underground source of drinking water (USDW). Groundwater restoration helps ensure that any mobilized constituents do not affect aquifers adjacent to the ore zone.

The goal of groundwater restoration will be to return the concentration of hazardous constituents in the Production Zone to an NRC-approved background concentration or to the maximum concentration limit (MCL), whichever is higher, or to an alternate standard approved by NRC using Best Practicable Technology (BPT). The pre-mining baseline groundwater quality and class of use will be determined by the baseline groundwater

quality sampling program which will be performed for each wellfield, as compared to the groundwater use categories defined by the WDEQ, Water Quality Division (WQD). Baseline, as defined for this project, will be the mean of the pre-mining groundwater baseline data for each wellfield, after removal of outliers or anomalous data. Restoration will be demonstrated in accordance with Chapter 11, Section 5(a)(ii) of the WDEQ, Land Quality Division Rules and Regulations and NUREG-1569 Section 6.

The evaluation of restoration of the groundwater within the Production Zone shall be based on the average baseline groundwater quality over the Production Zone. Baseline groundwater quality will be collected for each wellfield from the MP-wells (monitor wells completed in the planned Production Zone). The evaluation of restoration will be conducted on a parameter by parameter basis. Restoration Target Values (RTVs) are established for the list of baseline water quality parameters. The RTVs for the wellfields will be the average of the pre-mining values. Table 6-1 entitled "Baseline Water Quality Parameters", lists the parameters included in the RTVs.

Because of the number of sample results used for the average baseline determination, the spatial distance over which the samples are distributed, and the variability between sample results, the final restoration concentration achieved for a particular chemical constituent should be a function of the average baseline and the variability found between sample results used for baseline determination. Accordingly, the target restoration values will be a function of the average baseline, the range of results found in the baseline samples and the variability between sample results as defined by statistical methods agreed upon by the WDEQ-LQD and Uranium One. The range of individual restoration values achieved should fall between tolerances calculated with the mine unit baseline data base, using the same tolerance limit method previously provided in Section 5.8 under Upper Control Limit (UCL) calculations.

Baseline values will not be changed unless the operational monitoring program indicates that baseline groundwater quality has changed significantly due to accelerated movement of groundwater, and that such change justifies redetermination of baseline groundwater quality. Such a change would require re-sampling of groundwater monitoring wells and review and approval by the WDEQ.

Table 6-1: Baseline, Restoration and Post-Restoration Stability Monitoring Parameters

Physical and Field Water Quality Parameters		
Dissolved Oxygen	Electrical Conductivity, field	
pH, field	Temperature	
General Water Quality Parameters		
pH, lab	Ammonia	
Electrical Conductivity, lab	Alkalinity	
Total Dissolved Solids	Nitrate-Nitrite as N	
Total Suspended Solids	Turbidity	
Major Ions		
Calcium	Bicarbonate	
Magnesium	Carbonate	
Potassium	Chloride	
Sodium	Sulfate	
Radiological		
Gross alpha	^{226}Radium, dissolved	
Gross beta	^{228}Radium, dissolved	
^{210}Lead	^{222}Radon	
^{210}Polonium	^{230}Thorium	
Trace and Minor Elements		
Aluminum	Fluoride	Nickel, dissolved
Arsenic, dissolved	Iron, dissolved	Selenium, dissolved
Barium, dissolved	Iron, total	Silica, total
Boron, dissolved	Lead, dissolved	Uranium, dissolved
Cadmium, dissolved	Manganese, total	Vanadium, dissolved
Chromium, dissolved	Mercury, dissolved	Zinc, dissolved
Copper, dissolved	Molybdenum, dissolved	

Baseline values will not be changed unless the operational monitoring program indicates that baseline groundwater quality has changed significantly due to accelerated movement of groundwater, and that such a change justifies redetermination of baseline groundwater quality. Such a change would require re-sampling of groundwater monitoring wells, to include review and approval by the WDEQ.

Residual elevated concentrations of constituents of concern may remain following groundwater restoration activities. These residual elevated concentrations, also known as 'hot spots" could potentially impact groundwater outside of the exempted aquifer. The mean wellfield concentration +/- 2 standard deviations will be the primary indicator of a hot spot. If a hot spot is identified using that criterion, additional evaluation will be conducted to determine potential impacts that a hot spot could have on groundwater quality outside of the exempted aquifer. The additional evaluation may include, but is not limited to, trend analysis, solute transport modeling, collection of extra water samples, or analysis of added parameters (to assess post-restoration redox conditions). Based on the results of the analysis, additional restoration would be conducted as needed to ensure the protection of groundwater quality outside the exempted aquifer.

6.1.2 Estimate of Post-Mining Groundwater Quality

Uranium One has estimated the post-mining groundwater quality at the proposed project is based on the experience from Cogema Mining, Inc. in Production Units 1 through 9 at the Irigaray ISR project (Cogema, 2004), and Mine Units (MU) 2 through 5 at the Christensen Ranch ISR Project located in the Powder River Basin near the proposed Ludeman Project. The Irigaray and Christensen data was selected because of the proximity and similar geologic conditions to those at the proposed Ludeman Project. Cogema employed ammonium bicarbonate lixiviant with hydrogen peroxide as the oxidant during early mining operations at the Irigaray Project and a sodium bicarbonate lixiviant with gaseous oxygen at Christensen Ranch. In May 1980, the lixiviant system for Irigaray was converted to sodium bicarbonate chemistry with gaseous oxygen as the oxidant. The water quality database for the Irigaray ISR Project is extensive because it represents 5 wellfields located in a 200-acre site.

The groundwater quality of the Irigaray and Christensen ore zones after mining was established by sampling each of the designated restoration wells. The post-mining mean of the analytical results from Irigaray Production Units 1 through 9 and Christensen Mine Units 2 through 5 are presented in Table 6-2.

As discussed in previous sections, past pilot-scale operations were conducted on the west side (Leuenberger Project) and east side (North Platte Project) of the proposed Ludeman Project area. Three, five-spot patterns in the "M" sand (80 Sand) and one pattern in the "N" sand (70 Sand) were mined at the Leuenberger site utilizing a sodium bicarbonate

lixiviant solution in combination with carbon dioxide and oxygen. Pilot operations at the North Platte Project site utilized a similar lixiviant makeup, except hydrogen peroxide was used as the oxidant instead of oxygen. Post-mining mean concentrations of baseline groundwater quality parameters for the ore zone at the Leuenberger site are also shown on Table 6-2 along with a range of parameter concentrations for the Leuenberger Irigaray and Christensen Ranch sites. Uranium One does possess some restoration information for the North Platte Project. However, no information on post-mining groundwater quality for the North Platte Project has been located. Uranium One expects the post-mining groundwater quality at the proposed Ludeman Project will be similar to the ranges shown on Table 6-2. Since ammonia will not be used at the Ludeman Project, ammonia results will be most similar to Leuenberger. The success of groundwater restoration at the Christensen Ranch site, Irigaray site, Leuenberger site, and North Platte site is discussed in Section 6.1.6.

Table 6-2 Post-Mining Groundwater Quality

Parameter (units)	Christensen Ranch Post-Mining Mean (MUs 2-5)	Irigaray Post-Mining Mean (MUs 1-9)	Leuenberger "M" sand (80-Sand) Post-Mining Mean Concentration	Range of Post Mining Mean Concentrations For All Projects
Dissolved Aluminum (mg/l)	≤0.1	<1.037	0.06	0.06-1.037
Ammonia as N (mg/l)	0.70	23	NA	0.7-23
Dissolved Arsenic (mg/l)	0.04	<0.601	0.011	0.011-0.601
Dissolved Barium (mg/l)	≤0.1	<1.067	<0.10	<0.1-1.067
Boron (mg/l)	≤0.1	<0.442	<0.25	0.1-0.442
Dissolved Cadmium (mg/l)	≤0.01	<0.979	<0.01	0.01-0.979
Dissolved Chloride (mg/l)	146	277	78.2	78-277
Dissolved Chromium (mg/l)	≤0.05	<1.018	<0.05	<0.05-1.018
Dissolved Copper (mg/l)	≤0.01	<0.828	<0.05	<0.01-0.828
Fluoride (mg/l)	0.11	<1	0.27	0.11-0.27
Total and Dissolved Iron (mg/l)	0.93	<1.098	0.05	0.05-1.098
Dissolved Mercury (mg/l)	≤0.001	<0.971	<0.001	<0.001-0.971
Dissolved Magnesium (mg/l)	56.4	45.7	NA	45.7-56.4
Total Manganese (mg/l)	0.64	1.249	0.18	0.18-1.249
Dissolved Molybdenum (mg/l)	≤0.1	<1.067	<0.10	<0.1-1.067
Dissolved Nickel (mg/l)	0.07	<1.018	<0.05	<0.05-1.018
Nitrate + Nitrite as N (mg/l)	0.25	<3	0.31	0.25-3

Table 6-2 Post-Mining Groundwater Quality

Parameter (units)	Christensen Ranch Post-Mining Mean (MUs 2-5)	Irigaray Post-Mining Mean (MUs 1-9)	Leuenberger "M" sand (80-Sand) Post-Mining Mean Concentration	Range of Post Mining Mean Concentrations For All Projects
Dissolved Lead (mg/l)	≤0.05	<1.018	<0.05	<0.05-1.018
Radium-226 (pCi/L)	384	200.5	1,463	200-1,463
Dissolved Selenium (mg/l)	3.57	0.247	0.022	0.022-3.57
Dissolved Sodium (mg/l)	712	827	440	440-827
Sulfate (mg/l)	890	639	394	394-890
Uranium (mg/l)	14.37	7.411	21.8	7.4-21.8
Vanadium (mg/l)	0.34	<1.067	0.22	0.22-1.067
Dissolved Zinc (mg/l)	0.02	<0.065	0.05	0.02-0.065
Dissolved Calcium (mg/l)	300	199.2	209	199-300
Bicarbonate (mg/l)	1,864	1343	1,418	1,343-1,864
Carbonate (mg/l)	0.88	<2	15	0.88-15
Dissolved Potassium (mg/l)	11	9	20.2	9-20
Total Dissolved Solids (TDS) @ 180°F (mg/l)	3,282	2451	1,807	1,807-3,282

6.1.3 Groundwater Restoration Method

The groundwater restoration program consists of two stages, the restoration stage and the stability monitoring stage. The restoration stage typically consists of two phases:

1) Groundwater sweep, and
2) Groundwater treatment.

These phases are designed to optimize restoration equipment used in treating groundwater and to minimize the volume of groundwater consumed during the restoration stage. Uranium One will monitor the quality of groundwater in selected wells, as needed, during restoration to determine the efficiency of the operations and to determine if additional or alternate techniques are necessary. Online production wells used during restoration will be sampled for uranium concentration and for conductivity to determine restoration progress on a pattern-by-pattern basis.

The sequence of the activities will be determined by Uranium One based on operating experience, hydraulic characteristics of the aquifer at the time of restoration and waste water disposal capacity.

A reductant may be added at any time during the restoration stage to lower the oxidation potential of the mining zone. Either a sulfide or sulfite compound may be added to the injection stream in concentrations sufficient to establish reducing conditions within the mining zone.

Reductants are beneficial because several metals, solubilized by oxidation during the leaching process, are known to form stable, insoluble compounds, primarily as sulfides, under reduced conditions. Dissolved metal compounds that are precipitated under reducing conditions include those of arsenic, molybdenum, selenium, uranium and vanadium.

6.1.3.1 Groundwater Sweep

Groundwater sweep may be used as a stand-alone process where groundwater is pumped from a wellfield without reinjection. This causes an influx of baseline quality groundwater from the perimeter of the mining unit, which sweeps the affected portion of the aquifer. The cleaner baseline groundwater has a lower ion concentration that acts to strip the cations that have attached to the clays during mining. Additionally, oxidized production groundwater located near the perimeter of the wellfield is also drawn inside the boundaries of the wellfield. Groundwater sweeps may also be used in conjunction with the groundwater treatment phase of restoration. The groundwater produced during groundwater sweeps are disposed of in the deep disposal wells.

Due to the limited success and excessive consumption of groundwater during remedial sweeps at other operations, Uranium One anticipates that use of groundwater sweeps will be very limited, or not used at all at the proposed Ludeman Project.

6.1.3.2 Groundwater Treatment

Either following, or in conjunction with, the groundwater sweep phase, if used, groundwater will be pumped from the mining zone to treatment equipment at the surface. Ion exchange, reverse osmosis (RO) treatment equipment will be utilized during this phase of restoration.

Groundwater recovered from the restoration wellfield will first be passed through an ion exchange system prior to RO treatment and disposed in the deep disposal wells or it will be re-injected into the wellfield. The ion exchange columns exchange the majority of the contained soluble uranium for chloride. Additionally, prior to or following ion exchange

treatment, the groundwater may be passed through a decarbonation unit to remove residual carbon dioxide that remains in the groundwater after mining.

All or some portion of the recovered restoration groundwater can be sent to the RO unit. The purposes of the RO unit are as follows:

1. To reduce the total dissolved solids in the affected groundwater;
2. To reduce the quantity of groundwater that must be removed from the aquifer to meet restoration limits;
3. To concentrate the dissolved compounds from the restoration flow in a smaller volume of brine to facilitate waste disposal; and
4. To enhance the exchange of ions from the formation due to the large difference in ion concentration in the recirculated restoration flow.

The RO passes a high percentage of the groundwater through the membranes, leaving 60 to 90 percent of the dissolved salts in the brine water or concentrate. The clean water, called permeate, will be re-injected or stored for use in the mining process. The permeate may also be de-carbonated prior to re-injection into the wellfield. The brine water that is rejected contains the majority of dissolved salts in the affected groundwater and is sent for disposal in the deep disposal wells. Make-up water, derived from groundwater produced from a wellfield that is in a more advanced state of restoration, water from the raw water system, groundwater purged from an operating wellfield, or a combination of these sources, may be added prior to the RO or wellfield injection stream to control the amount of "bleed" in the restoration area.

As described previously, at any time during the process, a chemical reductant, which will be used to create reducing conditions in the mining zone, may be metered into the restoration wellfield injection stream. The concentration of reductant injected into the formation is determined by how the mining zone groundwater reacts with the reductant. The goal of reductant addition is to decrease the concentrations of redox sensitive elements.

The chemical reductant added to the injection stream during this stage will scavenge any oxygen and reduce the oxidation-reduction potential (Eh) of the aquifer. During mining operations, certain trace elements are oxidized. By adding the reductant, the Eh of the groundwater in the aquifer is lowered, thereby decreasing the solubility of these elements.

If necessary, sodium hydroxide may be used during the groundwater treatment phase to return the groundwater to baseline pH levels. This will assist in immobilizing certain parameters such as trace metals.

6.1.4 Estimate of Treated Pore Volumes

The number of pore volumes treated and re-injected during the groundwater treatment phase will depend on the efficiency of the RO in removing total dissolved solids (TDS) and the success of the reductant in lowering the uranium and trace element concentrations in the aquifer. The following subsections provide an evaluation with respect to the number of pore volumes (PVs) of treatment that are currently anticipated to achieve restoration of the Production Zone aquifer. This includes evaluation of similar ISR projects, both in the Powder River Basin and at the proposed Ludeman Project site.

6.1.4.1 Christensen Ranch and Irigaray ISR Projects Pore Volumes

As previously described, previous ISR operations at the Irigaray and Christensen Ranch Projects are similar to those that will be performed at the proposed Ludeman Project and evaluation of restoration efforts at these other sites provides valuable information with respect to anticipated methods, durations and pore volumes requirements. Table 6-3 presents a summary of the restoration volumes for Irigaray and Christensen Ranch. As shown in the table, the average number of PVs extracted and treated/reinjected/or disposed was 13.7 for Irigaray and 12.6 for Christensen. However, several points are presented that suggest that the number PVs required to restore the aquifer at the proposed Ludeman Project will be less than what was required at Christensen Ranch and Irigaray. Circumstances at both Christensen Ranch and Irigaray resulted in increased PVs to achieve restoration goals including the following:

- Groundwater sweep, the initial phase of restoration performed, was often largely ineffective and in some cases may have exacerbated the problem; and
- RO was continued in some wellfields after it was apparent that little improvement in water quality was occurring.

Table 6-3 Restoration volumes for Christensen and Irigaray

SCHEDULE OF PORE VOLUMES				
CHRISTENSEN			IRIGARAY	
UNIT	PVD		UNIT	PVD
MU2	14.4		PU 1-3	18.4
MU3	19.8		PU 4-5	13.9
MU4	12.8		PU 6	9.5
MU5	10.1		PU 7	14.3
MU6	6.0		PU 8	12.5
			PU 9	13.0
Average	**12.6**		**Average**	**13.7**

Results of the effectiveness of groundwater sweep (or lack of it) were clearly demonstrated in the Christensen Ranch Wellfield Restoration report (CRWR) (COGEMA 2008). Example plots from that report of mean wellfield water quality at the end of mining, groundwater sweep, RO and stabilization monitoring are attached as Addendum 6-A. Plots of total dissolved solids for MU3, MU5 and MU6 (Figures 6-A-1, 6-A-2 and 6-A-3, from the respective MU Data Packages of the Christensen Ranch Wellfield Restoration report), indicate minimal improvement following groundwater sweep at MU3 and MU5 and an actual increase in concentrations of indicator parameters at MU6. Following application of RO, the TDS values at MU5 and MU6 decreased to levels below the target Restoration Goal. Uranium concentrations increased in MU5 and MU6 following groundwater sweep (Figures 6-A-4 and 6-A-5 from the respective Mine Unit Data Packages of the CRWR), and then was significantly lowered during RO. Approximately 1.8, 4.8, and 1.5 PVs of groundwater were removed from MU3, MU5 and MU6, respectively, during groundwater sweep. This groundwater removal was consumptive by design, in that none of it was returned to the aquifer. Based on the results, minimal benefit, if any, was derived from this phase of restoration. Minimizing or eliminating groundwater sweep in the restoration process will reduce the number of PVs required to reach restoration goals.

Based on a review of the uranium and conductivity concentration trend plots from the Irigaray recovery wells during restoration (included in the Irigaray Mine Wellfield Restoration Report (Cogema 2004)), in some cases, RO treatment was continued longer than necessary, or at least longer than any improvements to groundwater quality were occurring. Figures 6-A-1 through 6-A-5 from the Irigaray report show that RO was often continued for several PVs beyond the point that groundwater quality had stabilized. The additional PVs of RO treatment resulted in no direct benefit to aquifer water quality and resulted in consumptive use of the groundwater resources. RO treatment typically results in disposal of approximately 20 percent of the recovered groundwater with reinjection of the remaining 80 percent following treatment. Terminating RO once groundwater quality has stabilized will minimize the consumptive use of groundwater and reduce the number of PVs of treatment.

The net result of each of these strategies - immediate restoration following production, elimination of groundwater sweep, and terminating RO once restoration is achieved or groundwater quality has stabilized - should reduce the number of PVs required to achieve aquifer restoration. It is difficult to quantify how effective each of these strategies will be until actual field measured data become available. Substantial justification of the number of PVs estimated for restoration of the proposed Ludeman Project wellfields following ISR mining using analytical methods or numerical modeling, given the degree of uncertainty that exists in many of the parameters that would be used in such a demonstration, is not appropriate at this time. The preferred approach is to use existing analogs to the site, and to adjust the PV approximation based on "lessons learned" from those sites.

6.1.4.2 Leuenberger ISR Pilot Project Pore Volumes

Restoration results from the ISR pilot project performed by UNC-Teton in 1980 (Catchpole) at the Leuenberger Site, located in the northwest portion of the proposed Ludeman Project area, have been evaluated as an on-site analog. This information is directly applicable to expectations for the proposed Ludeman Project, since the Leuenberger pilot project was performed in the same formation and aquifer that will be mined at the proposed Project. Three, five-spot patterns were installed and operated utilizing a bicarbonate leach solution in the 80 Sand at the Leuenberger ISR pilot project. The total affected wellfield pore volume from mining was determined to be 5,089,136 gallons considering flare. Restoration of the 80 Sand was initiated on February 25, 1981 and terminated December 20, 1981. Phase 1 of restoration consisted of groundwater treatment using ion exchange and EDR. Approximately 6,456,750 gallons were recovered from the production wells and treated through ion exchange with approximately 93 percent of the treated groundwater being re-injected into the recovery zone. Phase 1 resulted in the reduction of TDS by an average of 57 percent and rapid cleanup of all other most internal wellfield parameters.

Phases 2 and 3 of the 80 Sand restoration consisted of a directional sweep and treatment from injection and production wells on the far upgradient and downgradient areas of the wellfield and reinjection of treated groundwater into the center portions of the wellfield. A total of 8,721,453 gallons of groundwater were recovered and treated with ion exchange during these phases; including 4,902,333 gallons, which were treated through the EDR unit.

Aquifer restoration was completed during Phase 4, which consisted of withdrawing groundwater from the downgradient area of the wellfield and reinjecting treated groundwater to upgradient areas. A total of 7,413,145 gallons of groundwater were recovered and treated with ion exchange during this phase, including 3,549,215 gallons which were treated through the EDR.

In total, approximately 22,591,350 gallons of groundwater were recovered during the ten months of restoration of the 80 Sand pilot wellfield and treated using ion exchange and EDR. This represents approximately 4.4 pore volumes of the affected wellfield area. After a one-year stabilization period, all parameters remained either below restoration goals or within the range of acceptable baseline values.

In addition to pilot operations in the 80 Sand, a single, five-spot pattern was installed in the 70 Sand and operated utilizing a bicarbonate leach solution from January 1980 to May of 1981. Restoration of this pattern began in June of 1981. The total affected pore volume of the 70 Sand from pilot operations was determined to be 2,626,786 gallons. A five-phase restoration sequence was used to complete the 70 Sand restoration. The phases included recirculation of mining zone groundwater through the ion exchange circuit

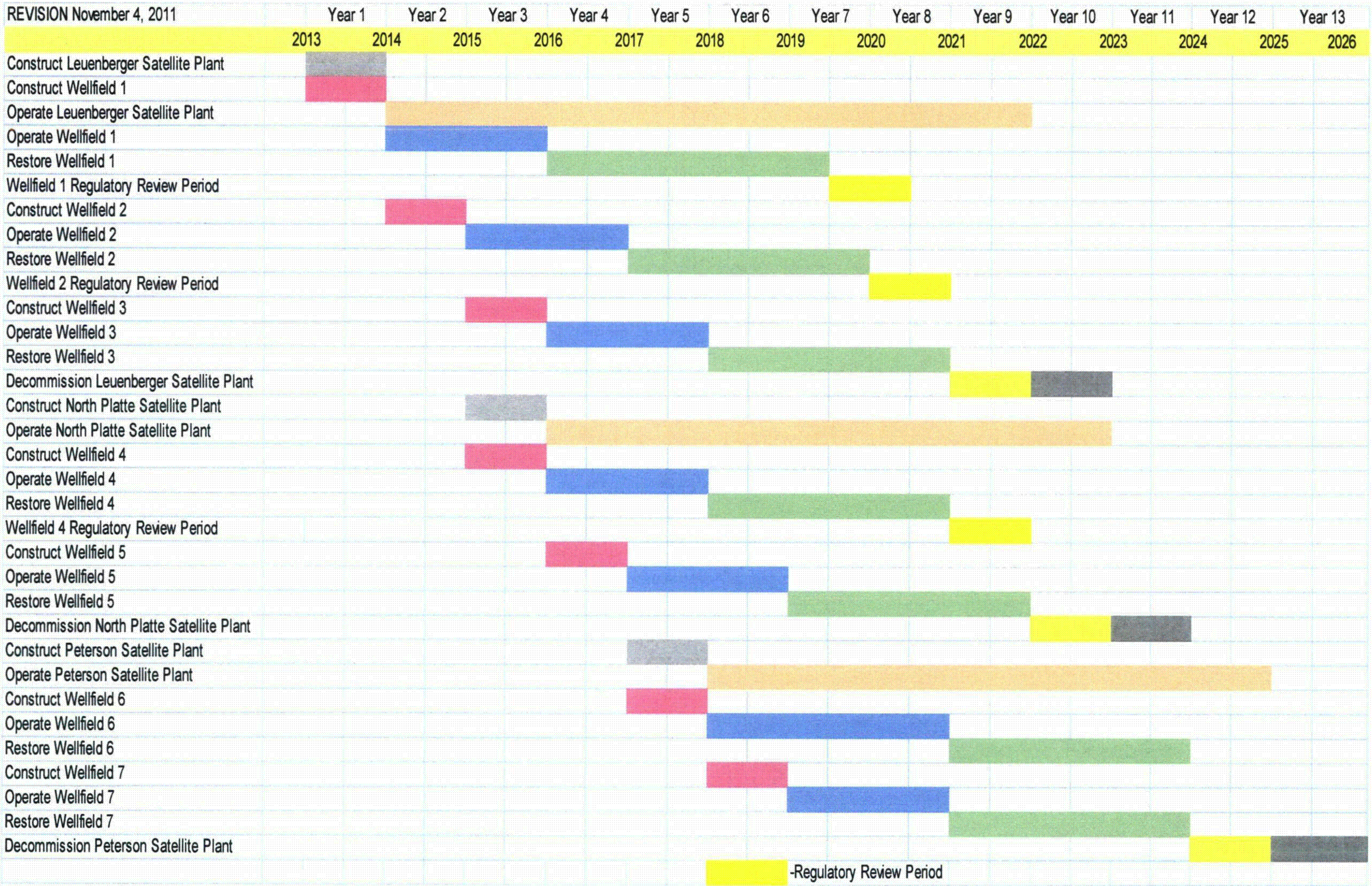
(Phase 1), water blending and partial transfer of mining zone groundwater to the 80 Sand wellfield operations (Phase 2), and induced groundwater sweep (Phases 3 through 5). No EDR treatment was utilized. A total of 6,321,079 gallons of groundwater were recovered through all five phases of restoration, or approximately 2.4 pore volumes of treatment.

Based on these data from the Leuenberger Pilot Project, it is reasonable to anticipate restoration at the proposed project will require significantly less pore volumes than was performed for the Irigaray and Christensen Ranch Projects. Uranium One anticipates that on the order of four to six pore volumes may be required for restoration.

6.1.5 Restoration Schedule

The proposed project production schedule is shown in Figure 6-1, and includes the estimated schedule for restoration. Based on current information, the estimated time for the restoration of Wellfields 1 and 2 is estimated at three and a half years and two and a half years, respectively. The estimated time of restoration for Wellfield 1 is based on six pore volumes (approximately 360,000,000 gallons) through reverse osmosis (RO) at a rate of 300 gallons per minute (gpm) treatment rate, equaling 2.3 years, plus one year stability monitoring. The Wellfield 2 restoration schedule is based on 6 pore volumes (approximately 150,000,000 gallons) through RO treatment at a rate of 300 gpm equaling approximately 0.9 years, plus one year stability monitoring. Restoration of Wellfields 3 through 7 is estimated to be three years each, more or less, depending on the size of each wellfield. The restoration schedule includes a period of time for regulatory review following the restoration of the final wellfield at each Satellite facility. As the proposed Ludeman Project is further developed, the restoration schedule will be refined.

Figure 6-1 Proposed Ludeman Operations and Restoration Schedule



6.1.6 Effectiveness of Groundwater Restoration Techniques

The groundwater restoration methods described in this application have been successfully applied at other uranium ISR facilities in the Powder River Basin, as well as in Nebraska and Texas. A number of uranium ISR mines in Wyoming, Nebraska, and Texas have successfully restored groundwater and obtained regulatory approval of restoration using these techniques. The two ISR facilities described in the following paragraphs are located in the Powder River Basin near the proposed Ludeman Project.

Smith Ranch/Highland Uranium Project - Groundwater restoration activities at the Smith Ranch-Highland Uranium Project currently operated by Power Resources, Inc. (PRI) have been approved by the NRC and the WDEQ for the R&D operations and for the A Wellfield during commercial operations. In 1987, the NRC confirmed successful restoration of the Q Sand project. Although one well exhibited uranium and nitrate levels above the target restoration values, the wellfield averages on a whole were below the targets.

In 2004, the NRC concurred with the WDEQ's determination that the A-wellfield at Highland had been restored in accordance with the applicable regulatory requirements (USNRC, 2004). Not all of the parameters were returned to baseline conditions, but the groundwater quality was consistent with the pre-mining class of use.

Willow Creek Project - Groundwater restoration activities at the Willow Creek Uranium Project operated by Cogema Mining, Inc. (now Uranium One USA, Inc.) have been approved by the NRC and the WDEQ for Production Units 1 through 9 at Wilow Creek. Post-mining groundwater quality in the nine production units was described in Section 6.1.2. The WDEQ determined that 27 of 29 constituents were restored below the restoration target values. Only bicarbonate and manganese did not meet the baseline range. However, WDEQ determined that these two constituents met the criteria of pre-mining class of use. Based on this, the WDEQ determined that the groundwater, as a whole, had been returned to its pre-mining class of use and that the post-restoration groundwater conditions did not significantly differ from the background groundwater quality.

In 2006, the NRC concurred with the WDEQ's determination that Wellfields 1 through 9 at Willow Creek had been restored in accordance with the applicable regulatory requirements (USNRC, 2006). NRC determined that Cogema used BPTs and concurred that the WDEQ class-of-use standards were met.

6.1.7 Potential Environmental Impacts of Groundwater Restoration

Based on the effectiveness of groundwater restoration at other ISR mines in the Powder River Basin, and the history of previous acceptable restoration of pilot tests at the Leuenberger site (located within the proposed project area), Uranium One expects that the proposed groundwater restoration techniques will successfully return the Production Zone at the proposed project to the restoration target values or the standard class of use. As discussed in Section 6.1.1, the purpose of restoring the groundwater to these restoration target values is to protect adjacent groundwater that is outside the Production Zone. If a constituent cannot technically or economically be restored to its restoration target value within the exploited Production Zone, WDEQ and NRC will require that Uranium One demonstrate that leaving the constituent at a higher concentration will not be a threat to public health and safety, the environment, or produce an unacceptable impact to the use of adjacent groundwater resources. Uranium One believes that the application of proven BPTs for groundwater restoration and the regulatory requirements, both State and Federal, that are in place will ensure that there is no adverse impact on groundwater quality outside the Production Zone.

Uranium One has estimated post-mining groundwater quality restoration values based on the results achieved by COGEMA Mining, Inc. (Cogema, 2004). Results from Production Units 1 through 9 at the Willow Creek ISR project, located in the Powder River Basin near the proposed project, and is described in Section 6.1.2. The Willow Creek data was selected because of the availability of extensive quantities of relevant data, its general proximity to the proposed Ludeman Project, and the similar geologic conditions with respect to the proposed project site. COGEMA employed ammonium bicarbonate with hydrogen peroxide as the oxidant during early mining operations. In May 1980, the lixiviant system for the entire site was converted to sodium bicarbonate chemistry with gaseous oxygen as the oxidant. The water quality database is extensive because it represents nine production units located in a 30-acre site.

The groundwater quality of the Willow Creek Production Zone after mining was established by sampling each of the designated restoration wells. The post-mining mean of the analytical results from Production Units 1 through 9 is presented in Table 6-2. The chemical alteration of the Production Zone Aquifer can be observed through comparison of the post-mining mean concentrations with the baseline concentrations. Uranium One expects similar baseline and post-mining groundwater quality at the proposed Ludeman Project.

6.1.7.1 Alternatives for Groundwater Quality Restoration

Various groundwater restoration techniques for proposed usage by Uranium One have been shown to be successful at other ISR recovery operations in the Powder River Basin.

The groundwater sweep, permeate/reductant injection and groundwater treatment have been documented to successfully restored groundwater to pre-mining quality.

All the historical and proposed aquifer restoration methods consume some volume of groundwater. Groundwater recovered during groundwater sweeps is generally disposed directly into the wastewater treatment system. Approximately 20 to 25 percent of the groundwater treatment flow through the RO system is disposed as RO brine. This consumption of groundwater is an unavoidable consequence of groundwater treatment. Impacts and groundwater usage during operations and restoration are discussed in more detail in Section 7.2.5.1.

Liquid wastes generated from production and restoration activities are generally managed at ISR facilities by solar evaporation ponds, deep well injection, and/or land application. The use of deep waste disposal well(s) is considered by Uranium One to be the best alternative to dispose of these types of wastes in addition to surge ponds. Each proposed Satellite facility will have two surge ponds (one as a primary and one as a backup) to store liquid waste in case a deep disposal well becomes inoperable, or during routine maintenance of the deep disposal wells. The proposed project deep well(s) will isolate liquid wastes generated by the project from any underground source of drinking water (USDW). These wells must be authorized by the State of Wyoming under a Class I UIC Permit. Uranium One has considered a wide range of liquid treatment/disposal methods for use at the proposed project. The alternatives analysis considered three primary waste streams from ISR operation:

- Plant eluant;
- Wellfield purge water; and
- RO reject produced during wellfield restoration.

A "design basis influent" was developed for the three typical ISR wastewater streams to be managed as well as the projected water quality characterization for blending the waste streams. The alternatives analysis was completed stepwise with the development of a common evaluation basis, screening of potentially applicable treatment technologies, development of candidate treatment trains, and technical and cost evaluation of the treatment trains. The initial screening of treatment technologies included evaluation of each technology for implementability, flexibility, maintainability, and relative capital and operating costs. The retained technologies were developed into treatment options and then the comparative evaluation of each option was conducted in parallel for each waste stream. Both capital and annual operating costs were developed for each option in order to calculate a net present value. The costs developed were comparative order-of-magnitude estimates intended for comparison purposes and were based on an ISR model case that could then be scaled to a particular operation. Costs that were common to all

options such as regulatory reporting, project management, and administrative costs were not included.
On any site where geologic and hydrogeologic conditions would allow, deep well injection is the current preferred method for wastewater disposal. Deep well injection is permitted primarily on the condition that potential sources of drinking water cannot be adversely impacted by the deep well operation, rather than by the quality and characteristics of the wastewater injected. Deep well "discharge standards" as incorporated into a permit are based on the mine operator's characterization of the waste stream. This method was considered potentially suitable for all ISR waste streams.

The Deep Well option presents additional environmental, safety and health benefits including the following:

- Minimize worker exposure to concentrated brine streams that may contain uranium and byproduct material;
- Minimize the required footprint and therefore land disturbed by the system;
- Minimize the residual, either solid or liquid, stored onsite and also shipped offsite. There is no offsite transportation of residual required with a deep well; and
- Minimize the requirement for chemicals and other commodities.

The following discussion provides a description of each treatment/disposal method considered and the relevant characteristics that led to the selection of deep well injection as the preferred alternative.

Land Application

Land application is feasible and has been historically used at some ISR facilities as a wastewater treatment/disposal method, generally in conjunction with deep well disposal and/or spray/solar evaporation. However, discharges through land application may be required to meet surface water quality standards. If land-applied water is not treated to stringent standards, there is a potential for future environmental liability due to accumulation of contaminants in the soil or groundwater below the land application surface area. For this reason land application was not retained in the screening process for further consideration.

Mechanical Evaporation

Mechanical evaporation utilizing equipment that requires either gas or electric power was considered. Evaporation is energy-intensive, but produces the smallest possible volume of waste for disposal. Disposal costs per unit volume can be evaluated against the evaporator operations cost to determine the economic viability of evaporation as a post-treatment step. For this evaluation it is assumed that a volume reduction of approximately

95% is achieved. This method was considered potentially suitable for all ISR waste streams.

Chemical Precipitation and Reverse Osmosis

Chemical precipitation and reverse osmosis which can utilize the chemical precipitation step to either pre-treat the wastewater for more efficient operation of the reverse osmosis system or use the chemical precipitation step to treat the brine was considered. Both a brine residual and a sludge are formed. This method was considered potentially suitable for all ISR waste streams.

Spray/Solar Evaporation

Spray/solar evaporation utilizing natural evaporation and enhancing the rate by spraying water to increase the surface area, which was assumed to provide a 95% volume reduction for this evaluation, was considered. While solar evaporation is technically feasible, the evaporation rate and length of the evaporation season must be considered in parallel with the flow rate of water to be treated. Evaporation pond size may become infeasibly large if the evaporation rate is low. If sprayers are used for evaporation enhancement, overspray due to high winds must be controlled. Additional issues with evaporation ponds include dust and dirt blown in, and the eventual need to remove salts and accumulated solids.

Based on this comparative evaluation, the deep well management option for ISR wastewater provides clear economic and environmental advantages. All solid wastes will be properly managed. Non-contaminated solid waste will be disposed in an offsite solid waste landfill permitted by the county in which it is located. Contaminated wastes will be shipped to a NRC or Agreement State-licensed facility for disposal.

6.1.8 Groundwater Restoration Monitoring

6.1.8.1 Monitoring During Active Restoration

During restoration, lixiviant injection is discontinued and the quality of the groundwater is constantly being improved, thereby greatly diminishing the possibility and relative impact of an excursion. Therefore, the groundwater monitoring ring wells (M-Wells), overlying aquifer wells (MO or MS Wells), and underlying aquifer wells (MU or MD Wells) will be sampled once every 60 days and analyzed for the excursion parameters, chloride, total alkalinity and conductivity during active restoration. Groundwater levels will also be obtained at these wells prior to sampling.

In the event that unforeseen conditions (such as snowstorms, flooding, and/or equipment malfunction) occur, the WDEQ will be contacted if any of the wells cannot be monitored within 65 days of the last sampling event.

The mining zone will be monitored on a frequency adequate to determine success of restoration, optimize efficiency of restoration techniques, and determine any areas of the wellfield that is need additional attention. Samples will be monitored for all of the parameters shown in Table 6-1 at the start of restoration; and all, or selected parameters through restoration, as needed.

Table 6-4 Restoration Groundwater Monitoring Schedule and Analysis

Restoration Phase	Sample Origin	Frequency	Analytical Parameters
Post Mining	Designated Restoration Wells Ore Zone	Once	WDEQ Guideline 8 Water Level
	Monitor Wells Ore Zone Monitors Underlying Zone Overlying Zone	Biweekly	Excursion Parameters
Restoration	Recovery Stream Composite	Weekly	HCO_3/CO_3, SO_4, Cl, Conductivity, pH, Uranium
		As Needed	Add Na, Ca, TDS, etc.
		End of each pore volume displacement	WDEQ Guideline 8
	Designated Restoration Wells Ore Zone	End of each restoration phase	WDEQ Guideline 8
	Monitor Wells Ore Zone Monitors Underlying Zone Overlying Zone	Every 60 days	Excursion Parameters
Post-Restoration Stability	Designate Restoration Wells Ore Zone	Beginning, Middle and End	WDEQ Guideline 8
	Monitor Wells Ore Zone Monitors Underlying Zone Overlying Zone	Every 60 days	Excursion Parameters

6.1.8.2 Restoration Stability Monitoring

As specified in WDEQ-LQD Guideline 4, a minimum six-month groundwater stability monitoring period is required to show that the restoration goal has been adequately maintained. WYDEQ has recently requested that this period be extended to 12 months. The following restoration stability monitoring program will be performed during the stability period:

- The groundwater monitoring ring wells will be sampled quarterly and analyzed for the excursion parameters (chloride, total alkalinity (or bicarbonate) and conductivity); and
- At the beginning, middle and end of the stability period, the MP-Wells will be sampled and analyzed for the parameters in Table 6-1.

In the event that unforeseen conditions (such as snowstorms, flooding, and/or equipment malfunction) occur, the WDEQ will be contacted if any of the M-Wells or MP-Wells cannot be monitored within 65 days of the last sampling event.

The criteria to establish restoration stability will be based on wellfield averages for groundwater quality. A determination of aquifer stablility should be based made upon the "trends" in the data; i.e., a stable aquifer should not exhibit rapid upward or downward trends or be oscillating back and forth over a wide range of values. The data is evaluated against baseline groundwater quality and variability to determine if the restoration goal is met and if the groundwater is indeed restored. If increasing trends are confirmed during the stability period for all or part of a wellfield, then an evaluation of the potential cause of the increasing trends will be conducted and corrective actions will be taken, including continued restoration using BPT's if needed.

6.1.9 Well Plugging and Abandonment

Wellfield plugging and surface reclamation will be initiated once the regulatory agencies concur that the groundwater has been adequately restored and that groundwater quality is stable. All production, injection and groundwater monitoring wells will be abandoned in accordance with Chapter 11, Section 8 of the WDEQ-LQD Rules and Regulations, to prevent adverse impacts to groundwater quality or quantity. Well plugging and abandonment methods at the proposed Ludeman project will be same as those described in Section 6.2.1 of the LRA for SUA-1341.

6.1.10 Restoration Wastewater Disposal

Uranium One plans to install deep disposal wells (EPA UIC Class I non-hazardous wells) at the proposed Ludeman Project as the primary liquid waste disposal method. Each Satellite facility will have two surge ponds in case the deep disposal well becomes non-operational, or when routine maintenance is required. One pond is designed to support well operations and the second is a redundant back up. Uranium One believes that permanent deep disposal is preferable to evaporation in evaporation ponds. Disposal in a Class I well permanently isolates the wastewater from the public and the environment. Alternatives assessed by Uranium One for wastewater disposal are discussed in Section 8.

Based on the expected post-mining concentrations of groundwater quality constituents discussed in Section 6.1.2 and the proposed groundwater restoration techniques discussed in Section 6.1.3, Uranium One projects that the restoration wastewater disposal stream for injection will exhibit the range of characteristics shown in Table 6-5.

Table 6-5 Projected Ludeman Restoration Wastewater Stream Water Quality

Parameter	Units	Minimum Concentration	Maximum Concentration
Calcium	mg/l	350	700
Magnesium	mg/l	50	150
Sodium	mg/l	400	950
Potassium	mg/l	40	90
Carbonate	mg/l	0	0.3
Bicarbonate	mg/l	200	1250
Sulfate	mg/l	900	2500
Chloride	mg/l	300	1000
Nitrate	mg/l	0.01	0.5
Fluoride	mg/l	0.01	2
Silica	mg/l	10	65
Total Dissolved Solids	mg/l	1000	15000
Conductivity	μmho/cm	1000	5500
Alkalinity	mg/l	165	1025
pH	Std. Units	6	12
Arsenic	mg/l	0.01	1
Cadmium	mg/l	0.0001	0.001
Iron	mg/l	0.5	15
Lead	mg/l	0.01	0.04
Manganese	mg/l	0.01	1.5
Mercury	mg/l	0.0001	0.001
Molybdenum	mg/l	0.1	1.5
Selenium	mg/l	0.01	0.5
Uranium	mg/l	0.05	15
Ammonia	mg/l	0.1	0.5
Radium-226	pCi/l	500	5000

All liquid wastes generated during groundwater restoration at the proposed Ludeman Project will be disposed in the planned deep wells. An application is currently being

prepared for submittal to the WDEQ for a Class I UIC Permit for the deep disposal wells at the proposed Ludeman Project.

6.2 PLANS AND SCHEDULES FOR RECLAIMING DISTURBED LANDS

6.2.1 Introduction

All lands disturbed by the mining project will be returned to their pre-mining land use of livestock grazing and wildlife habitat, unless an alternative use is justified and is approved by the landowner, e.g., the rancher desires to retain roads and/or buildings. The objectives of the surface reclamation effort is to return the disturbed lands to production capacity of equal to, or better than was existing prior to mining. The soils, vegetation and radiological baseline data will be used as a guideline in evaluating final reclamation. This section provides a general description of the proposed facility decommissioning and surface reclamation plans for the proposed Ludeman Project. The following is a list of general decommissioning activities:

- Plug and abandon all wells as detailed in Section 6.1.9;
- Determination of appropriate cleanup criteria for structures (Section 6.3.2) and soils (Section 6.4);
- Radiological surveys and sampling of all facilities, process-related equipment and materials onsite to determine their degree of contamination and identify the potential for personnel exposure during decommissioning;
- Removal from the site of all contaminated equipment and materials to an approved, licensed facility for disposal or reuse, or relocation to an operational portion of the mining operation as discussed in Section 6.3.2.2;
- Decontamination of items to be released for unrestricted use to levels consistent with the requirements of NRC;
- Survey excavated areas for contamination and remove contaminated materials to a licensed disposal facility;
- Perform final site soil radiation surveys;
- Backfill and recontour all disturbed areas and roads; and
- Establish permanent revegetation on all disturbed areas.

The following sections describe in general terms the planned decommissioning activities and procedures for the proposed Ludeman Project facilities. Uranium One will, prior to final decommissioning of an area, submit to the NRC a detailed Decommissioning Plan for review and approval at least 12 months before planned commencement of final

decommissioning. The QA plan presented in Section 5 of this TR is applicable to the decommissioning process as well.

6.2.2 Surface Disturbance

The primary surface disturbances associated with ISR mining are the sites containing the Satellite facilities. Surface disturbances also occur during the well drilling program, pipeline and well installations, and road construction. These more superficial disturbances involve relatively small areas or have very short-term impacts.

Disturbances associated with the Satellite facilities, pipeline installations, and wellfield header houses will be for the life of those activities and topsoil will be stripped from the areas prior to construction. Disturbance associated with drilling and pipeline installation is limited, and is reclaimed and reseeded no later than the first fall or spring seeding season. Vegetation will normally be reestablished over these areas within two years. Surface disturbance associated with development of access roads will occur at the proposed Ludeman Project site and topsoil will be stripped from the road areas prior to construction and stockpiled.

Surface reclamation in the wellfield production units will vary in accordance with the development sequence and the mining/reclamation timetable. Final surface reclamation of each wellfield production unit will be completed after approval of groundwater restoration stability and the completion of well abandonment activities. Surface preparation will be accomplished as needed so as to blend any disturbed areas into the contour of the surrounding landscape.

Wellfield decommissioning will consist of the following steps:

1. The first step of the wellfield decommissioning process will involve the removal of surface equipment. Surface equipment primarily consists of the injection and production feed lines, header houses, electrical and control distribution systems, well boxes, and wellhead equipment. Wellhead equipment such as valves, meters or control fixtures will be salvaged to the extent possible;
2. Removal of buried wellfield trunk line piping and surface power lines;
3. A final background gamma survey will be conducted over the entire wellfield area to identify any contaminated earthen materials requiring removal to disposal;
4. Final revegetation of the wellfield areas will be conducted according to the revegetation plan in section 6.2.5; and
5. All piping, equipment, buildings, and wellhead equipment will be surveyed for contamination prior to release in accordance with the NRC guidelines for decommissioning.

An ongoing process during ISL mining operations is drilling, which results in the production of drill cuttings. Drill cuttings are classified as Technically Enhanced Naturally Occurring Radioactive Material (TENORM). TENORM drill cuttings will be buried in the drill pits. This method is discussed in a recent EPA report (EPA, 2007), which states "these wastes are typically deposited in pits on site, which are subsequently buried during reclamation. Some slight radioactivity may occur in accumulated solids in the pit bottoms". As discussed in Section 3, the Ludeman orebody ranges in grade from less than 0.05% to greater than 0.5%, with an average grade estimated at 0.1%. The relatively small volume of low concentration TENORM drill cuttings deposited at the bottom of the drill pits will not present a hazard. Additionally, TENORM material is not subject to the soil clean-up criteria from 10 CFR Part 40 Appendix A.

It is estimated that a significant portion of the equipment will meet release limits, which will allow disposal at an unrestricted solid waste landfill or unrestricted use. Other materials that are contaminated will be decontaminated until they meet release limits. If the equipment cannot be decontaminated to meet release limits, it will be disposed of at a licensed disposal facility.

Wellfield decommissioning will be an independent ongoing operation throughout the mining sequence. Once a production unit has been mined out and groundwater restoration and stability have been accepted by the regulatory agencies, the wellfield will be scheduled for decommissioning and surface reclamation.

6.2.3 Topsoil Handling and Replacement

In accordance with WDEQ-LQD requirements, topsoil is salvaged from building sites, permanent storage areas, main access roads, graveled wellfield access roads and chemical storage sites. Conventional rubber-tired, scraper-type earth moving equipment is typically used to accomplish such topsoil salvage operations. The exact location of topsoil salvage operations is determined by wellfield pattern placement and the final locations of access roads within the wellfields, determined during wellfield construction activities.

As described in Section 2.6, salvage depth varies within the proposed project area from non-existent to several feet in depth. However, typical topsoil stripping depths are expected to range from 3 to 6 inches.

Salvaged topsoil is stored in designated topsoil stockpiles. These stockpiles will be generally located on the leeward side of hills to minimize wind erosion. Stockpiles will not be located in drainage channels. The perimeter of large topsoil stockpiles may be bermed to control sediment runoff. Topsoil stockpiles will be seeded as soon as possible after construction with the permanent seed mix.

In accordance with WDEQ-LQD requirements, all topsoil stockpiles will be identified with a highly visible sign with the designation "Topsoil."

During mud pit excavation associated with well construction, exploration drilling and delineation drilling activities, topsoil will be separated from subsoil with a backhoe. When use of the mud pit is complete, all subsoil will be replaced and topsoil applied. Mud pits only remain open a short time, usually less than 30 days. Similarly, during pipeline construction, topsoil is stored separate from subsoil and is replaced on top of the subsoil after the pipeline ditch is backfilled.

6.2.4 Final Contouring

Recontouring of land where surface disturbances has taken place, will be restored to a surface configuration that will blend in with the natural terrain, and be consistent with the post mining land use. Since no major changes in the topography will result from the proposed ISR operation, a final contour map is not required. As a result, the pre-operation contours shown on Figure 2.1-1 will generally emulate post-production contour.

6.2.5 Revegetation Practices

Revegetation practices will be conducted in accordance with WDEQ-LQD regulations and the mine permit. During mining operations, the topsoil stockpiles, and as much as practical of the disturbed wellfield areas, will be seeded to establish a vegetative cover to minimize wind and water erosion. Prior to final reclamation, an area will normally be seeded with a nurse crop to establish a standing vegetative cover along with the permanent seed mix. A long-term temporary seed mix may be used in the wellfields and other areas where the vegetation will be disturbed again prior to final decommissioning and final revegetation. This long-term seed mix typically consists of one or more of the native wheat grasses (i.e. Western Wheatgrass, Thickspike Wheatgrass).

Permanent seeding is accomplished with a seed mix approved by the WDEQ-LQD. The permanent mix typically contains native wheat grasses, fescues, and clovers. Typical seeding rates will be 12 to14 lbs of pure live seed per acre.

The success of permanent revegetation in meeting land use and reclamation success standards will be assessed prior to application for bond release by utilizing the "Extended Reference Area" method as detailed in WDEQ-LQD Guideline No. 2 - Vegetation (March 1986). This method compares, on a statistical basis, the reclaimed area with adjacent undisturbed areas of the same vegetation type.

The Extended Reference Areas will be located adjacent to the reclaimed area being assessed for bond release and will be sized such that it is at least half as large as the area being assessed. In no case will the Extended Reference Area be less than 25 acres in size.

The WDEQ-LQD will be consulted prior to selection of Extended Reference Areas to ensure agreement that the undisturbed areas chosen adequately represent the reclaimed areas being assessed. The success of permanent revegetation and final bond release will be assessed by the WDEQ-LQD.

6.3 PROCEDURES FOR REMOVING AND DISPOSING OF STRUCTURES AND EQUIPMENT

The following sections describe in general terms the planned decommissioning activities and procedures for the proposed Ludeman facilities. Uranium One will, prior to final decommissioning of an area, submit to the NRC a detailed Decommissioning Plan for their review and approval at least 12 months before planned commencement of final decommissioning. The contract between the Licensee, waste disposal operator(s) and waste receiving facilities to dispose of 11e.(2) byproduct materials for the proposed Ludeman Project, will follow provisions as outlined in SUA-1341.

6.3.1 Preliminary Radiological Surveys and Contamination Control

Prior to process plant decommissioning, a preliminary radiological survey will be conducted to characterize the levels of contamination on structures and equipment and to identify any potential hazards. The survey will support the development of procedures for dealing with such hazards prior to commencement of decommissioning activities. In general, the contamination control program used during mining operations (as discussed in Section 5.7) will be appropriate for use during decommissioning of structures.

Based on the results of the preliminary radiological surveys, gross decontamination techniques will be employed to remove loose contamination before decommissioning activities proceed. This gross decontamination will generally consist of washing all accessible surfaces with high-pressure water. In areas where contamination is not readily removed by high-pressure water, a decontamination solution (e.g., dilute acid) may be used.

6.3.2 Removal of Process Buildings and Equipment

The majority of the process equipment in the process buildings will be reusable, as well as the buildings. Alternatives for the disposition of the building and equipment are discussed in this section.

All process or potentially contaminated equipment and materials at the process facilities including tanks, filters, pumps, piping, etc., will be inventoried, listed and designated for one of the following removal alternatives:

- Removal to a new licensed location for future use;
- Removal to a licensed facility for permanent disposal; or
- Decontamination to meet unrestricted use criteria for release, sale or other unrestricted use by others.

Uranium One believes that process buildings will be decontaminated, dismantled and released for unrestricted use at another location. If decontamination efforts are unsuccessful, the material will be sent to a permanent licensed disposal facility. Cement foundation pads and footings will be broken up and trucked to a solid waste disposal site or to a licensed 11e.(2) byproduct material disposal facility, if contaminated.

All waste that could pose a threat to human health and the environment will be disposed of offsite. This will effectively control, minimize, or eliminate post-closure escape of non-radiological hazardous constituents, leachate, contaminated rainwater or waste composition products to the ground or surface waters, or to the atmosphere.

6.3.2.1 Building Materials, Equipment and Piping to be Released for Unrestricted Use

Salvageable building materials, equipment, pipe and other materials to be released for unrestricted use will be surveyed for alpha contamination in accordance with NRC guidance. Release limits for alpha radiation are as follows:

- Removable alpha contamination of 1,000 dpm/100cm^2;
- Average total alpha contamination of 5,000 dpm/100 cm^2 over an area no greater than one square meter; and
- Maximum total alpha contamination of 15,000 dpm/100 cm^2 over an area no greater than 100 cm^2.

Decontamination of surfaces will be guided by the ALARA principle to reduce surface contamination to levels as far below the limits as practical. Particular attention will be given to equipment and structures in which radiological materials could accumulate in inaccessible locations including piping, traps, junctions, and access points. Contamination of these materials will be determined by surveys at accessible locations. Items that cannot be adequately characterized will be considered contaminated in excess of the limits and will be disposed at a properly licensed facility.

Non-salvageable contaminated equipment, materials, and dismantled structural sections will be sent off-site to a licensed facility for disposal. In most cases, the byproduct material will be shipped as Low Specific Activity (LSA-I) material, UN2912, pursuant to 49 CFR 173.427.

6.3.2.2 Preparation for Disposal at a Licensed Facility

If facilities or equipment are to be moved to a facility licensed for disposal of 11e.(2) byproduct material, the following procedures may be used.

- Flush inside of tanks, pumps, pipes, etc., with water or acid to reduce interior contamination, as necessary, for safe handling;
- The exterior surfaces of process equipment will be surveyed for contamination. If the surfaces are found to be contaminated the equipment will be washed down and decontaminated to permit safe handling;
- The equipment will be disassembled only to the degree necessary for transportation. All openings, pipe fittings, vents, etc., will be plugged or covered prior to moving equipment from the plant building;
- Equipment in the building, such as large tanks, may be transported on flatbed trailers. Smaller items, such as links of pipe and ducting material, may be placed in lined roll off containers or covered dump trucks or drummed in barrels for delivery to the disposal facility; and
- Contaminated buried process trunk lines and sump drain lines will be excavated and removed for transportation to a licensed disposal facility.

6.3.3 Decommissioning of Non-11e.(2) Hazardous Constituents

Uranium One will decommission all equipment and facilities associated with non-radiological hazardous constituents from both operation and decommissioning activities.

Storage tanks and conveyance piping associated with process chemicals that are hazardous will be cleaned to remove any residual chemicals. The tanks will then be transferred for use at other Uranium One facilities, sold to another operator, or disposed of at an approved off-site landfill. Tanks and piping will be cleaned by qualified individuals who are trained in the risks of the chemicals and in a manner that is protective of the environment. Proper personal protective equipment will be required during these activities.

Appropriate storage facilities for hazardous chemicals, domestic waste, and other non-radiological wastes generated during decommissioning will be located on-site. Storage of

these constituents will be done in accordance with OSHA, EPA, and WDEQ requirements.

6.3.4 Waste Transportation and Disposal

Materials, equipment, and structures that cannot be decontaminated to meet the appropriate release criteria will be disposed at a disposal site licensed by the NRC or an Agreement State to receive 11e.(2) byproduct material. Uranium One currently has an agreement with Pathfinder Mines to receive 11e.(2) byproduct material from the Willow Creek Project. An amended agreement for disposal of 11e.(2) byproduct material from the proposed Ludeman project will be in place before injection of lixiviant commences. A current disposal agreement will be maintained at a minimum of one licensed disposal facility throughout licensed operations.

Transportation of all contaminated waste materials and equipment from the site to the approved licensed disposal facility or other licensed sites will be handled in accordance with the Department of Transportation (DOT) Hazardous Materials Regulations (49 CFR Part 173) and the NRC transportation regulations (10 CFR 71).

6.4 METHODOLOGIES FOR CONDUCTING POST-RECLAMATION AND DECOMMISSIONING RADIOLOGICAL SURVEYS

The following sections describe in general terms the planned decommissioning activities and procedures for the proposed Ludeman facilities. Uranium One will, prior to final decommissioning of an area, submit to the NRC a detailed Decommissioning Plan for their review and approval at least 12 months before planned commencement of final decommissioning. Methodologies employed by Uranium One for conducting post-reclamation and decommissioning radiological surveys will be consistent with NUREG 1569, Section 6.4 and 10 CFR Part 40, appendix A, Criterion 6(6). In addition, Uranium One will observe guidance as presented in NUREG 1575 with respect to the planning, conducting, evaluating and documentation of radiological surveys. This is necessary to demonstrate compliance and final assessment of such surveys in order to meet established dose or risk-based criteria.

6.4.1 Cleanup Criteria

Surface soils will be cleaned up in accordance with the requirements of 10 CFR Part 40, Appendix A, including a consideration of ALARA goals and the chemical toxicity of uranium. The proposed limits and ALARA goals for cleanup of soils are summarized in Table 6-7. The process employed by Uranium One for determining cleanup criteria follows.

6.4.1.1 Determination of Radium Benchmark Dose

On April 12, 1999, the NRC issued a Final Rule (64 FR 17506) that requires the use of the existing soil radium standard to derive a dose criterion for the cleanup of byproduct material. The amendment to Criterion 6(6) of 10 CFR Part 40, Appendix A was effective on June 11, 1999. This "benchmark approach" requires that NRC licensees model the site-specific dose from the existing radium soil standard and then use that dose to determine the allowable quantity of other radionuclides that would result in a similar dose to the average member of the critical group. These determinations must then be submitted to NRC with the site reclamation plan or included in license applications. This section documents the modeling and assumptions made by Uranium One to derive a standard for natural uranium in soil for the proposed Ludeman Project.

Concurrent with publication of the Final Rule, NRC published draft guidance (64 FR 17690) for performing the benchmark dose modeling required to implement the final rule. Final guidance (NRC, 2003) was published as Appendix E to the Standard Review Plan for *In Situ* Leach License Applications (NUREG-1569). This guidance discusses acceptable models and input parameters. This guidance, guidance from the RESRAD Users Manual (ANL, 2001), the Data Collection Handbook (ANL, 1993) and site-specific parameters were used in the modeling as discussed in the following sections.

RESRAD Version 6.4 computer code (RESRAD) was used to model the proposed Ludeman Project site and calculate the maximum annual dose rate from the current radium cleanup standard.

The following supporting documentation for determination of the radium benchmark dose and the natural uranium soil standard (explained in Section 6.4.1.2) is attached:

- The RESRAD Data Input Basis (Appendix D-1) provides a summary of the modeling performed with RESRAD and the values that were used for the input parameters. A sensitivity analysis was performed for parameters which are important to the major component dose pathways and for which no site specific data was available;
- Selected graphs produced with RESRAD that present the results of the sensitivity analysis performed on the input parameters are attached (Appendix D-2);
- A full printout of the final RESRAD modeling results for the resident farmer scenario with the chosen input values is attached (Appendix D-3 and Appendix D-4). The printout provides the modeled maximum annual dose for calculated times for the 1,000-year time span and provides a breakdown of the fraction of dose due to each pathway; and
- Graphs produced with RESRAD that present the modeling results for the maximum dose during the 1,000 year time span for radium-226 and natural

uranium. A series of graphs depicting the summed dose for all pathways and the component pathways that contributes to the total dose are attached (Appendix D-5).

The maximum dose from Ra-226 contaminated soil at the 5 pCi/g-above-background cleanup standard, as determined by RESRAD, for the residential farmer scenario was 39.6 mrem/year. This dose was based upon the 5 pCi/g surface (0 to 6-inch) Ra-226 standard and was noted at time, t = 0 years. The two major dose pathways were external exposure and plant ingestion (water independent). For these two pathways, a sensitivity analysis was performed for important parameters for which no site specific information was available. The 39.6 mrem/year dose from radium is the level at which the natural uranium radiological end point soil standard will be based as described in the following section.

6.4.1.2 Determination of Natural Uranium Soil Standard

RESRAD was used to determine the concentration of natural uranium (U-nat) in soil distinguishable from background that would result in a maximum dose of 39.6 mrem/year. The method involved modeling the dose from a set concentration of natural uranium in soil. This dose was then compared to the radium benchmark dose and scaled to arrive at the maximum allowable natural uranium concentration in soil.

For ease of calculations, a preset concentration of 100 pCi/g U-nat was used for modeling the dose. The fractions used were 49.2 percent (or pCi/g) U-234, 48.6 percent (or pCi/g) U-238 and 2.2 percent (or pCi/g) U-235. The distribution coefficients that were selected for each radionuclide were RESRAD default values. A sensitivity analysis was performed using a range of distribution coefficients to evaluate potential effects of not using site specific data. All other input parameters were the same as those used in the Ra-226 benchmark modeling.

Using a natural uranium concentration in soil of 100 pCi/g, RESRAD determined a maximum dose of 6.9 mrem/yr. at time, t = 0 years. The printout of the RESRAD data summary is provided in Appendix A-3 and the dose figures generated with RESRAD are provided in Appendix A-4.

To determine the uranium soil standard, the following formula was used:

$$\text{Uranium Limit} = \left(\frac{100\ \text{pCi/g U-nat}}{6.9\ \text{mrem/yr U-nat dose}} \right) \text{x } 39.6\ \text{mrem/yr radium benchmark dose}$$

$$\text{Uranium Limit} = 574\ \text{pCi/g U-nat}$$

The natural uranium limit is applied to soil cleanup with the Ra-226 limit using the unity rule. To determine whether an area exceeds the cleanup standards, the standards are applied according to the following formula:

$$\left(\frac{\text{Soil Uranium Concentration}}{\text{Soil Uranium Limit}}\right)+\left(\frac{\text{Soil Radium Concentration}}{\text{Soil Radium Limit}}\right)<1$$

This approach will be used at the proposed Ludeman Project site to determine the radiological impact on the environment from releases of source and byproduct materials.

6.4.1.3 Uranium Chemical Toxicity Assessment

The chemical toxicity effects from uranium exposure are evaluated by assuming the same exposure scenario as that used for the radiation dose assessment. In the benchmark dose assessment for the resident farmer scenario, it was assumed that the diet consisted of 25 percent of the meat, fruits, and vegetables grown at the site. No intake of contaminated food through the aquatic or milk pathways was considered probable since it is unlikely the Ludeman area could support this activity with local vegetation. Also, the model showed that the contamination would not affect groundwater quality. Therefore, the same model will be used in assessing the chemical toxicity. The intake from eating meat was shown to be negligible compared to the plant pathway, and therefore is not shown here. This is confirmed by the results of the RESRAD calculations shown in Appendix A-3 and the figures generated with RESRAD shown in Appendix A-4.

The method and parameters for estimating the human intake of uranium from ingestion are taken from NUREG/CR-5512 Vol. 1 (NRC, 1992). The uptake of uranium in food is a product of the uranium concentration in soil and the soil-to-plant conversion factor. The annual intake in humans is then calculated by multiplying the annual consumption by the uranium concentration in the food. Since the soil-plant conversion factor is based on a dry weight, the annual consumption must be adjusted to a dry-weight basis by multiplying by the dry-weight to wet-weight ratio. Parameters for these calculations are given in Section 6.5.9 of the NUREG/CR-5512 Vol. 1 (NRC, 1992). Table 6-6 provides the parameters used in these calculations and results for leafy vegetables, other vegetables, and fruit. Annual intakes of 14 kg/year and 97 kg/year were assumed for leafy vegetables and other vegetables and fruit, respectively. Consistent with Appendix A-3 dose calculations, it was assumed that 25 percent of the food was grown on the site. It was also assumed that the uranium concentration in the garden or orchard was 574 pCi/g. This corresponds to the uranium benchmark concentration for surface soils. Using a conversion factor for natural uranium of 1 mg = 677 pCi, then 574 pCi/g is equivalent to 848 mg/kg. The human intake shown in the first column of Table 6-6, is equal to the product of the parameters given in the subsequent columns. Table 6-6 shows that the total annual uranium intake from all food sources from the site are 56 mg/yr.

The two-compartment model of uranium toxicity in the kidney from oral ingestion was used (ICRP, 1995) to predict the burden of uranium in the kidney following chronic uranium ingestion. This model allows for the distribution of the two forms of uranium in the blood, and consists of a kidney with two compartments, as well as several other compartments for uranium distribution, storage and elimination including the skeleton, liver, red blood cells and other soft tissues.

Table 6-6 Annual Intake of Uranium from Ingestion

Human Intake (mg/yr)	Soil Concentration (mg/kg)	Soil to Plant Ratio (mg/kg plant to mg/kg soil)	Annual Consumption (kg)	Dry Weight Wet Weight Ratio	Food Source
10.1	848	1.7E-2	3.5	0.2	Leafy Vegetables
38.6	848	1.4E-2	13	0.25	Other Vegetables
7.3	848	4.0E-3	12	0.18	Fruit
56.0					Total

The total burden to the kidney is the sum of the two compartments. The mathematical representation for the kidney burden of uranium at steady state can be derived as follows (ICRP, 1995):

$$Q_P = \frac{IR \times f_1}{\lambda_P \left(1 - f_{ps} - f_{pr} - f_{pl} - f_{pt} - f_{pk1}\right)}$$

Where:

- Q_P = uranium burden in the plasma, µg
- IR = dietary consumption rate, mg U/d
- f_1 = fractional transfer of uranium from GI tract to blood, unit less
- f_{ps} = fractional transfer of uranium from plasma to skeleton, unit less
- f_{pr} = fractional transfer of uranium from plasma to red blood cells, unit less
- f_{pl} = fractional transfer of uranium from plasma to liver, unit less
- f_{pt} = fractional transfer of uranium from plasma to soft tissue, unit less

f_{pk1} = fractional transfer of uranium from plasma to kidney, compartment 1, unit less

λ_p = biological retention constant in the plasma, d^{-1}

The burden in kidney compartment 1 is:

$$Q_{k1} = \lambda_P \times Q_P \times \frac{f_{pk1}}{\lambda_{k1}}$$

Where:

Q_{k1} = uranium burden in kidney compartment 1, mg

λ_{k1} = biological retention constant of uranium in kidney compartment 1, d^{-1}

Similarly, for compartment 2 in the kidney, the burden is:

$$Q_{k2} = \lambda_P \times Q_P \times \frac{f_{pk2}}{\lambda_{k2}}$$

Where:

Q_{k2} = uranium burden in kidney compartment 2, µg;

λ_{k2} = biological retention constant of uranium in kidney compartment 2, d^{-1};

f_{pk2} = fractional transfer of uranium from plasma to kidney compartment 2, unitless.

The total burden to the kidney is then the sum of the two compartments is:

$$Q_{k1} + Q_{k2} = \frac{IR \times f_1}{\left(1 - f_{ps} - f_{pr} - f_{pl} - f_{pt} - f_{pk1}\right)} \times \left(\frac{f_{pk1}}{\lambda_{k1}} + \frac{f_{pk2}}{\lambda_{k2}}\right)$$

The parameter input values for the two-compartment kidney model include the daily intake of uranium estimated for residents at this site, and the ICRP69 values recommended by the ICRP as listed below (ICRP, 1995). The daily uranium intake rate was estimated to be 0.15 mg/day (56.0 mg/year) from ingestion while residing at this site.

IR = 0.15 mg/day

f_l = 0.02

f_{ps} = 0.105
f_{pr} = 0.007
f_{pl} = 0.0105
f_{pt} = 0.347
f_{pk1} = 0.00035
f_{pk2} = 0.084
λ_{k1} = ln(2)/(5 yrs*365 days/yr)
λ_{k2} = ln(2)/7 days

Where, ln(2) = 0.693

Given a daily uranium intake of 0.15 mg/day at this site and the above equation, the calculated uranium in the kidneys is 0.010 mg U, or a concentration of 0.034 μg U/g kidney. This is 3.4 percent of the 1.0 μg U/g value that has generally been understood to protect the kidney from the toxic effects of uranium. Some researchers have suggested that mild effects may be observable at levels as low as 0.1 μg U/g of kidney tissue. Using 0.1 μg U/g as a criterion, then the intake is 34 percent of the level where mild effects may be observable.

The EPA evaluated the chemical toxicity data and found that mild proteinuria has been observed at drinking water levels between 20 and 100 μg/liter. Assuming water intake of two liters/day, this corresponds to an intake of 0.04 to 0.2 mg/day. Using animal data and a conservative factor of 100, the EPA arrived at a 30 μg/liter limit for use as a National Primary Drinking Water Standard (Federal Register/Vol.65, No.236/ December 7, 2000). This is equivalent to an intake of 0.06 mg/day for the average individual. Naturally, since large diverse populations are potentially exposed to drinking water sources that are regulated using these standards, the EPA is very conservative in developing limits.

This analysis indicates that a soil limit of 574 pCi/g of U-nat would result in an intake of approximately 0.15 mg/day. Using the most conservative daily limit corresponding to the National Primary Drinking Water standard, a soil limit of 230 pCi/g corresponds to the EPA intake limit from drinking water with a uranium concentration of 0.06 mg/day. Therefore exposure to soils containing 230 pCi/g of natural uranium should not result in chemical toxicity effects. Since the roots of a fruit tree would penetrate to a considerable depth, limiting subsurface uranium concentrations to 230 pCi/g will be considered appropriate as well.

ALARA considerations require that an effort be made to reduce contaminants to as low as reasonably achievable levels. The ALARA goals are normally based on a cost-benefit analysis. For the cleanup of gamma-emitting radionuclides, the cost of cleanup becomes

excessively high as soil concentrations and/or gamma emission rates become indistinguishable from background.

Cleanup of uranium mill sites has demonstrated that conservatively derived gamma action levels along with appropriate field survey and sampling procedures result in near background radium-226 concentrations for the site. In addition, the presence of a mixture of radium-226 and uranium will tend to drive the cleanup to even lower radium-226 concentrations. It is therefore believed that no specific ALARA goal is required for surface radium-226.

Uranium One proposes an ALARA goal of limiting the natural uranium concentration in the top 15 cm soil layer to 150 pCi/g, averaged over 100 m^2. With respect to chemical toxicity concerns, the uranium concentration should be limited to 225 pCi/g for all soil depths.

Table 6-7 Soil Cleanup Criteria and Goals

	Radium-226 (pCi/gm)		**Natural Uranium (pCi/gm)**	
Layer Depth	• *Limit*	*Goal*	*Limit*	*Goal*
Surface (0-15 cm)	5	5	225	150
Subsurface (15 cm layers)	15	15	225	225

6.4.2 Excavation Control Monitoring

Pre-reclamation radiological surveys will be conducted in a manner consistent with the baseline radiological surveys, described in Section 2.9, so that the data can be directly compared for identification of potentially contaminated areas. For example, a comprehensive gamma scan of the site will be performed, including conversion of raw scan data to three-foot HPIC-equivalent gamma exposure rate readings and/or to estimates of soil Ra-226 concentration. These data sets will be used to develop continuous estimates across the site. This will allow direct spatial comparisons with baseline survey maps for any area at the site. Both qualitative assessments and quantitative statistical comparisons between data sets can be made to assess significant differences, taking into account potential magnitudes of estimation uncertainty. In cases of identified contamination at the soil surface, subsurface soil sampling will also be conducted to determine the vertical extent of contamination that would require remediation under applicable soil cleanup criteria.

Uranium One will use hand-held and GPS-based gamma surveys to guide soil remediation efforts. Field personnel will monitor excavations with hand-held detection systems to guide the removal of contaminated material to the point where there is high probability that an area meets the cleanup criteria. Support will be provided by GPS-based gamma surveys periodically to more accurately assess the progress of excavation.

6.4.3 Surface Soil Cleanup Verification and Sampling Plan

Pre-reclamation surveys will also be conducted as described in Section 6.4.2 in areas where known contamination has occurred or the potential for unknown soil contamination exists. Cleanup of surface soils will be restricted to potentially contaminated areas. These potentially contaminated areas include areas where known spills have occurred and areas where there is potential for small unknown spills and other contamination including areas under and around header houses, wellheads, buried pipelines that contain radioactive material, radioactive materials storage areas, deep disposal well facilities, and liquid storage areas. Final GPS-based gamma surveys will be conducted in potentially contaminated areas. Areas will be divided into 100 m^2 grid blocks. Soil samples will be obtained from grid blocks with gamma count rates exceeding the gamma action level. The samples will be five-point composites and will be analyzed at an offsite laboratory for radium-226 and natural uranium.

Final status surveys after any remediation has occurred will also be conducted such that results can be directly compared to pre-operational baseline survey data. As with pre-reclamation surveys, final status gamma scan data will be converted to three-foot HPIC-equivalent gamma exposure rates and/or to estimates of soil Ra-226 concentrations. For aspects of the final status survey, pre-operational baseline data may be used instead of a physically separated reference area to provide information on background conditions for statistical comparative testing. Subsurface sampling will be conducted as part of the final status survey only if residual subsurface contamination is known to remain after any remediation has been completed. Other post-operational environmental monitoring data such as sediments, surface waters, groundwater, air particulates, radon, and vegetation may also be compared quantitatively and/or qualitatively against pre-operational baseline data.

There are other physical factors that influence gamma count rates other than radium-226 concentrations in soil and include source geometry and land topography. The vast majority of gamma readings in scanned areas were below 20 μR/hr. Data trends in a number of areas show several distinct regions with slightly higher gamma readings, indicative of higher levels of naturally occurring terrestrial radionuclides at or near the ground surface. Regions of significantly elevated gamma readings are very limited, and represent less than 1% of the survey area that possess gamma readings in excess of 25 μR/hr. In some cases, areas with higher readings have certain geomorphologic features

that appear to be associated with higher gamma exposure rates (e.g. hill tops, eroded areas, outcrops of exposed rocks or unusually colored soils). In other cases, there are no obvious features associated with the higher observed readings.

As such, gamma count rates may not be a reliable tool to provide a 95% assurance that the soil units meet the cleanup guidelines. The gamma action level established above, coupled with pre-ISR gamma survey results will provide sufficient evidence to indicate radium-226 soil concentrations above cleanup guidelines. This evidence will trigger soil removal activities and subsequent post remediation gamma surveys and soil sampling. Please refer to Section 2.9 of this Technical Report for a complete discussion of baseline radiological characteristic of soils on the proposed Ludeman Project site.

The results of the post-mining soil sampling will be compared to established soil cleanup goals for radium-226 and natural uranium to demonstrate the effectiveness of the reclamation activities including any confidence level that the soil units meet the cleanup guidelines.

6.4.4 Quality Assurance

Verification soil samples will be sent to a commercial laboratory for analysis of radium-226 and natural uranium. The commercial laboratory will be required to have a well-defined quality assurance program that addresses the laboratory's organization and management, personal qualifications, physical facilities, equipment and instrumentation, reference materials, measurement traceability and calibration, analytical method validation, standard operating procedures (SOPs), sample receipt, handing, storage, records, and appropriate licenses. Uranium One will maintain a laboratory QA file that will include, at a minimum, the laboratory's Quality Assurance Manual (QAM) and audit reports.

6.5 DECOMMISSIONING HEALTH PHYSICS AND RADIATION SAFETY

The health physics and radiation safety program for decommissioning will ensure that occupational radiation exposure levels will be kept as low as reasonably achievable during decommissioning. The Radiation Safety Officer, Radiation Safety Technician or designee will be on site during any decommissioning activities where a potential radiation exposure hazard exists. In general, the radiation safety program discussed in Section 5 of this TR will be used as the basis for development of the decommissioning health physics program. Health physics surveys conducted during decommissioning will be guided by applicable sections of Regulatory Guide 8.30 (USNRC, 2002) or other applicable standards at the time.

6.5.1 Records and Reporting Procedures

At the conclusion of site decommissioning and surface reclamation, a report containing all applicable documentation will be submitted to the NRC. Records of all contaminated materials transported to a licensed disposal site will be maintained for a period of five years or as otherwise required by applicable regulations at the time of decommissioning.

6.6 FINANCIAL ASSURANCE

Uranium One typically maintain financial surety instruments in the form of an Irrevocable Letter of Credit to cover the costs of reclamation including the costs of groundwater restoration, the decommissioning, dismantling and disposal of all buildings and other facilities, and the reclamation and revegetation of affected areas. Other approved forms of surety may be considered. Additionally, in accordance with NRC and WDEQ requirements, an updated Annual Surety Estimate Revision will be submitted to the NRC and WDEQ each year to adjust the surety instrument amount in response to changes in facility and its operations and in closure or decommissioning plans. After review and approval of the Annual Surety Estimate Revision by the NRC and WDEQ, Uranium One will revise the surety instrument to reflect the revised amount. Uranium One will:

1) Automatically extend the existing surety amount if the NRC has not approved the extension at least 30 days prior to the expiration date;
2) Revise the surety arrangement (with WDEQ approval) within three months of NRC approval of a revised closure (decommissioning) plan, if estimated costs exceed the amount of the existing financial surety;
3) Update the surety to cover any planned expansion or operational change not included in the annual surety update at least 90 days prior to beginning associated construction;
4) Update the surety in the event that an excursion of mining solutions is not recovered within 60 days; and
5) Provide NRC a copy of the surety-related correspondence submitted to the WDEQ, a copy of the surety review, and the final approved surety arrangement.

Groundwater restoration costs are based on treatment of one pore volume for groundwater sweep and six pore volumes for reverse osmosis and reductant addition. Wellfield pore volumes are determined using the following equation:

Wellfield Pore Volume = (Affected Ore Zone Area) x (Average Completed Thickness) x (Flare Factor) x (Porosity)

SUA-1341 authorizes an overall flare factor of 1.44 at the Willow Creek site. Accordingly, Uranium One is using a flare factor of 1.44 for the surety estimate. All critical ground water restoration factors (pore volume, flare factors, porosity and completed thickness) are identified in the surety estimate presented in Appendix E. However, the surety estimate presented in Appendix E was developed for the first year of the project. There will be no wellfield or satellite operations during the first year; therefore, no wellfield groundwater restoration, building or soil decontamination costs were carried through the cost summary. These costs will be rolled into the surety estimate during the annual update.

6.7 REFERENCES

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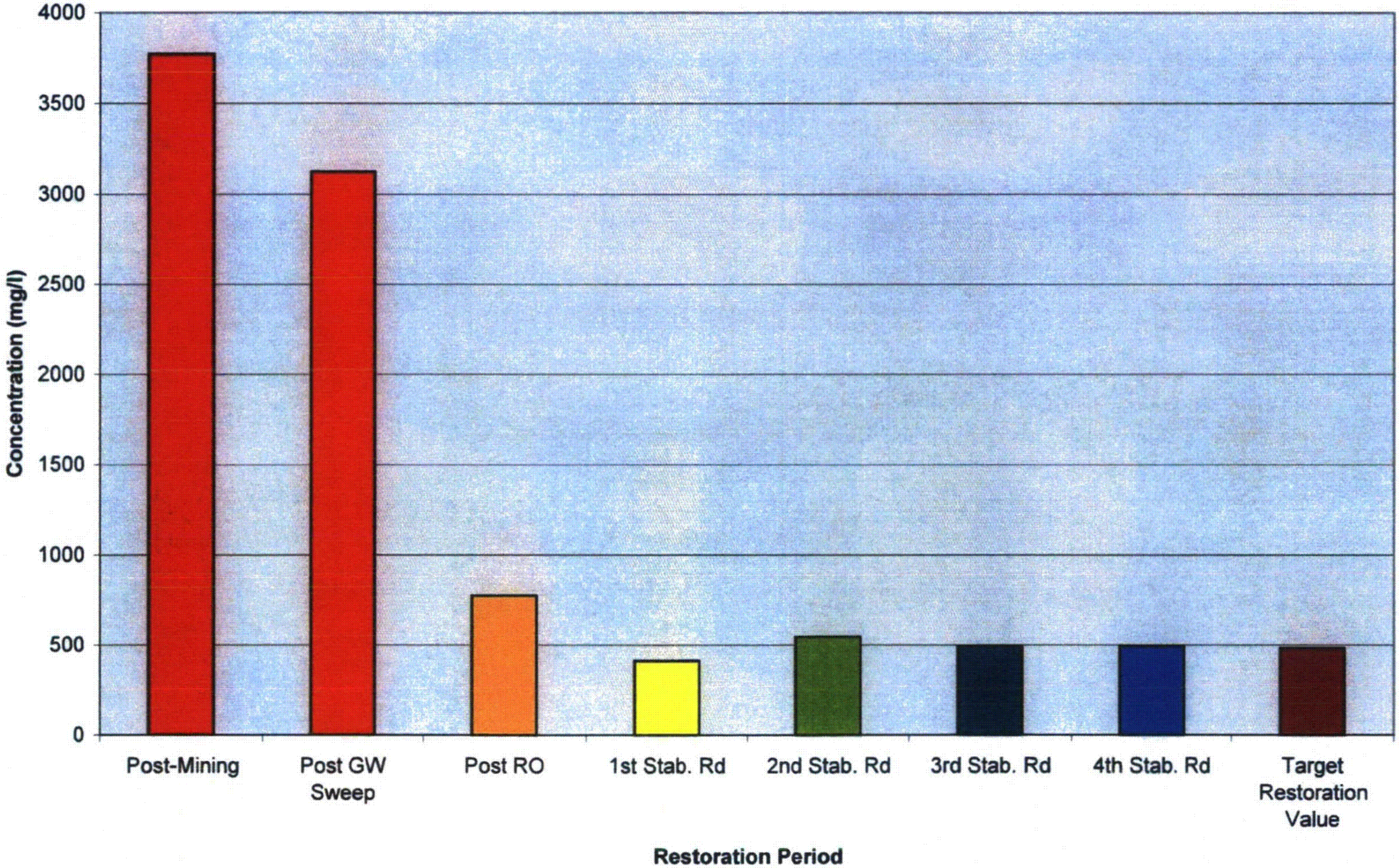
Leuenberger In Situ Pilot Project, M Zone Restoration Stability Report, UNC Teton Exploration Drilling, INC. Converse County, WY, Permit No. 2RD-522 March 18, 1983

Wyoming Department of Environmental Quality, *Vegetation*, Guideline #2, March 1986

ADDENDUM 6-A

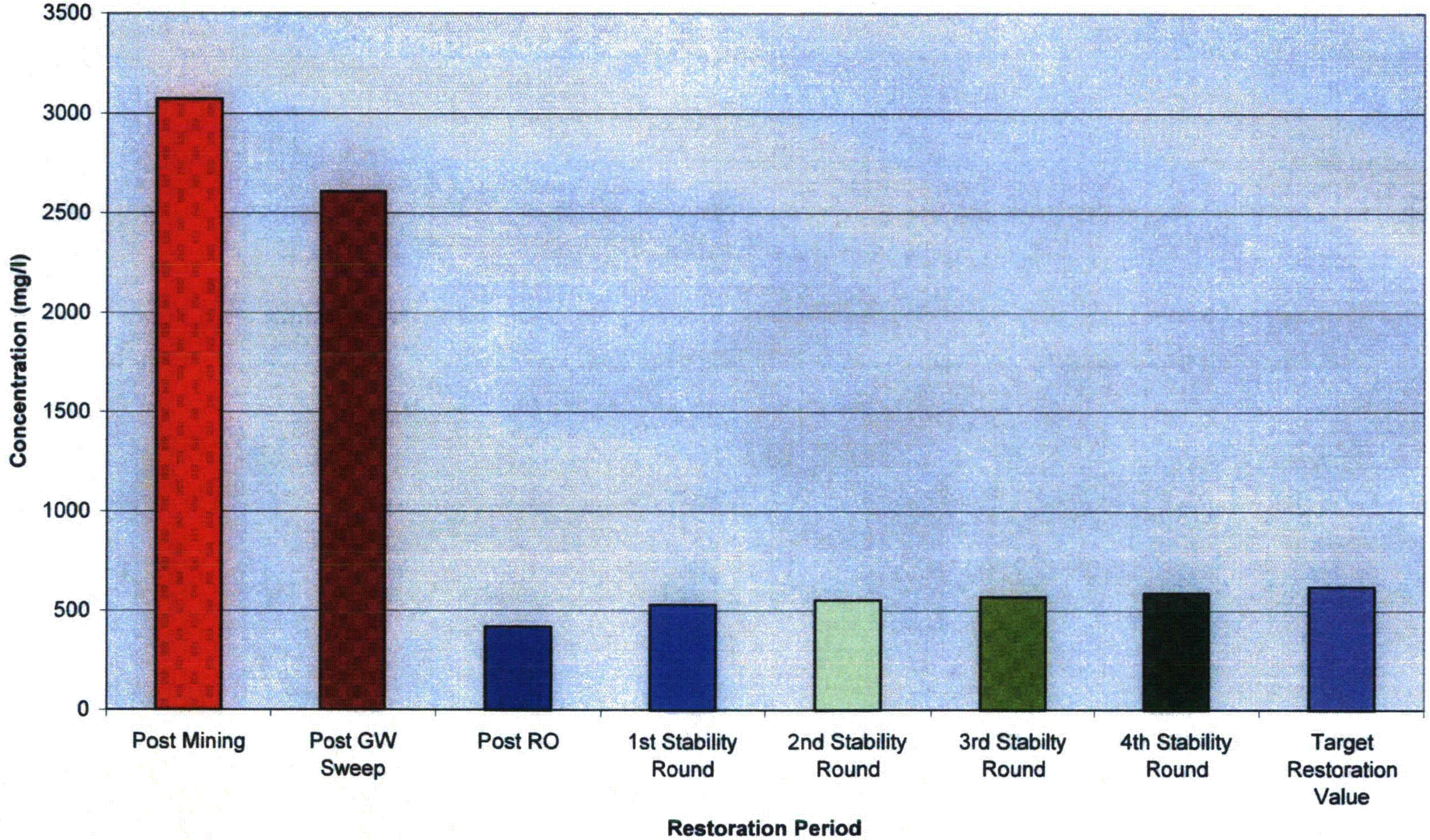
WILLOW CREEK WELLFIELD RESTORATION REPORT FIGURES

Figure 6-A-1 Mean TDS Concentration-Post Mining Through 4th Stability Round
Mine Unit 3, Christensen Ranch, Wyoming, Cogema Mining, Inc.



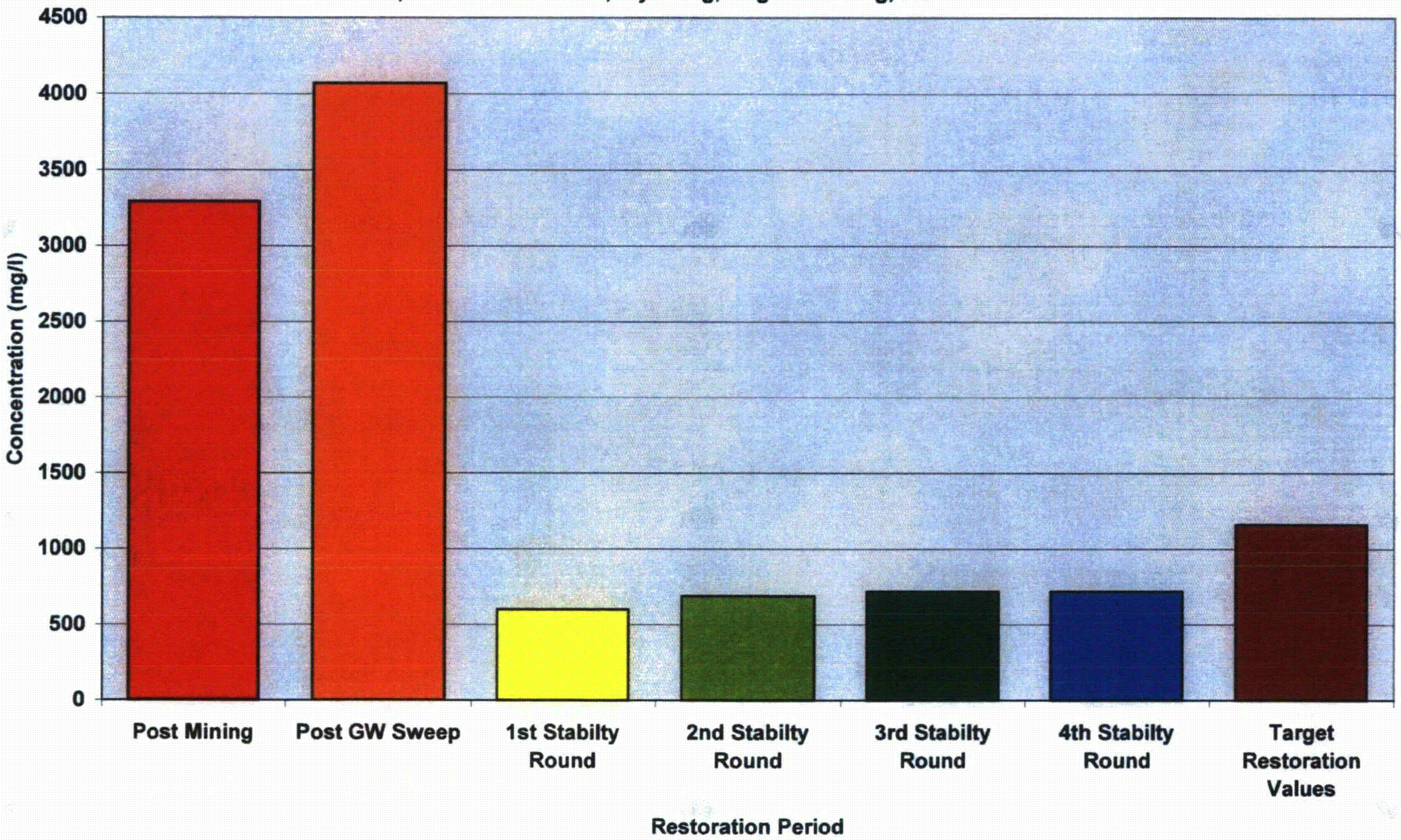
Cogema Mining, Inc., Wellfield Restoration Report Christensen Ranch Project Wyoming, March 2008.

Figure 6-A-2 Mean TDS Concentration-Post Mining Through 4th Stability Round
Mine Unit 5, Christensen Ranch, Wyoming, Cogema Mining, Inc.



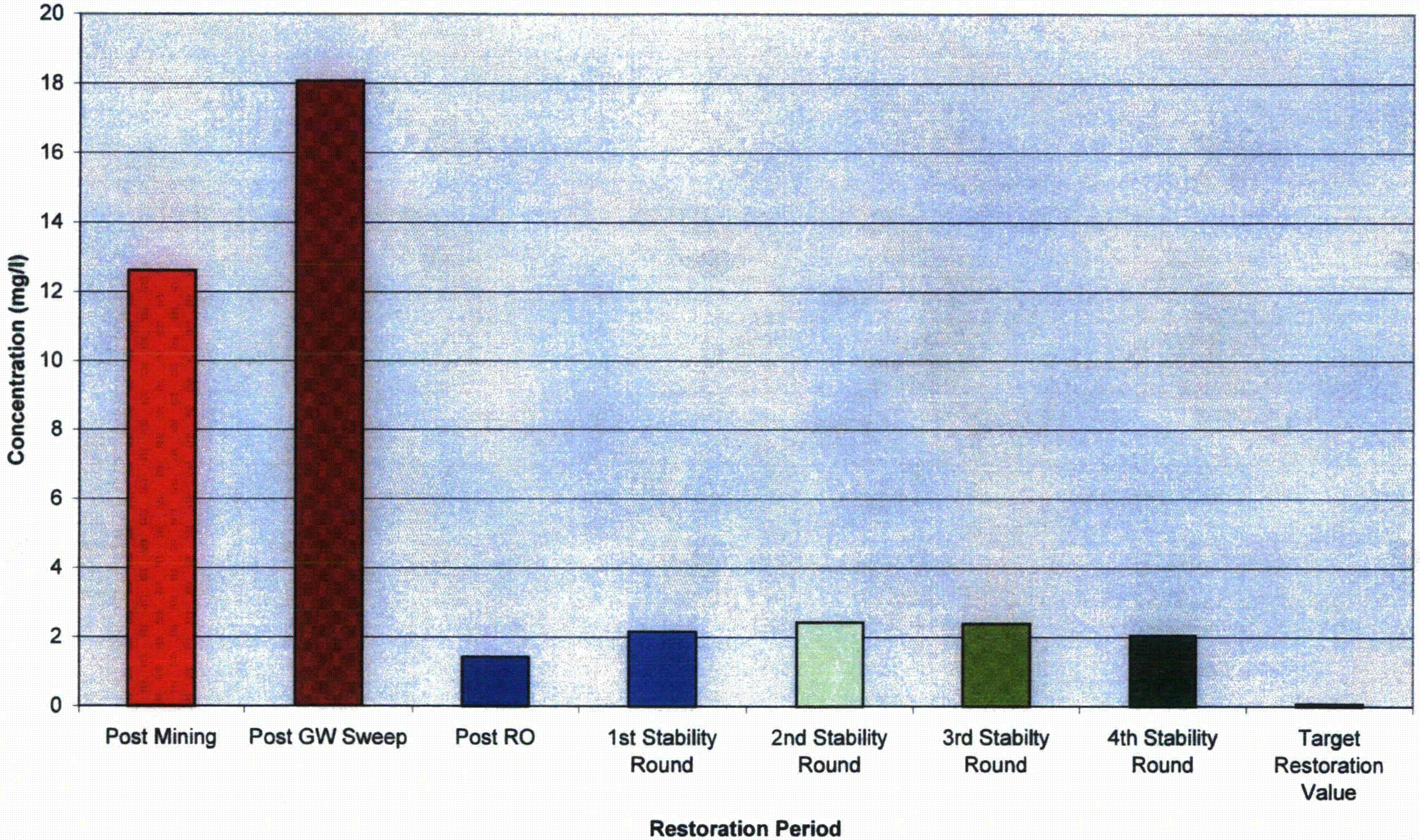
Cogema Mining, Inc., Wellfield Restoration Report Christensen Ranch Project Wyoming, March 2008.

Figure 6-A-3 Mean Total Dissolved Solids Concentration-Post Mining Through 4th Stability Round
Mine Unit 6, Christensen Ranch, Wyoming, Cogema Mining, Inc.



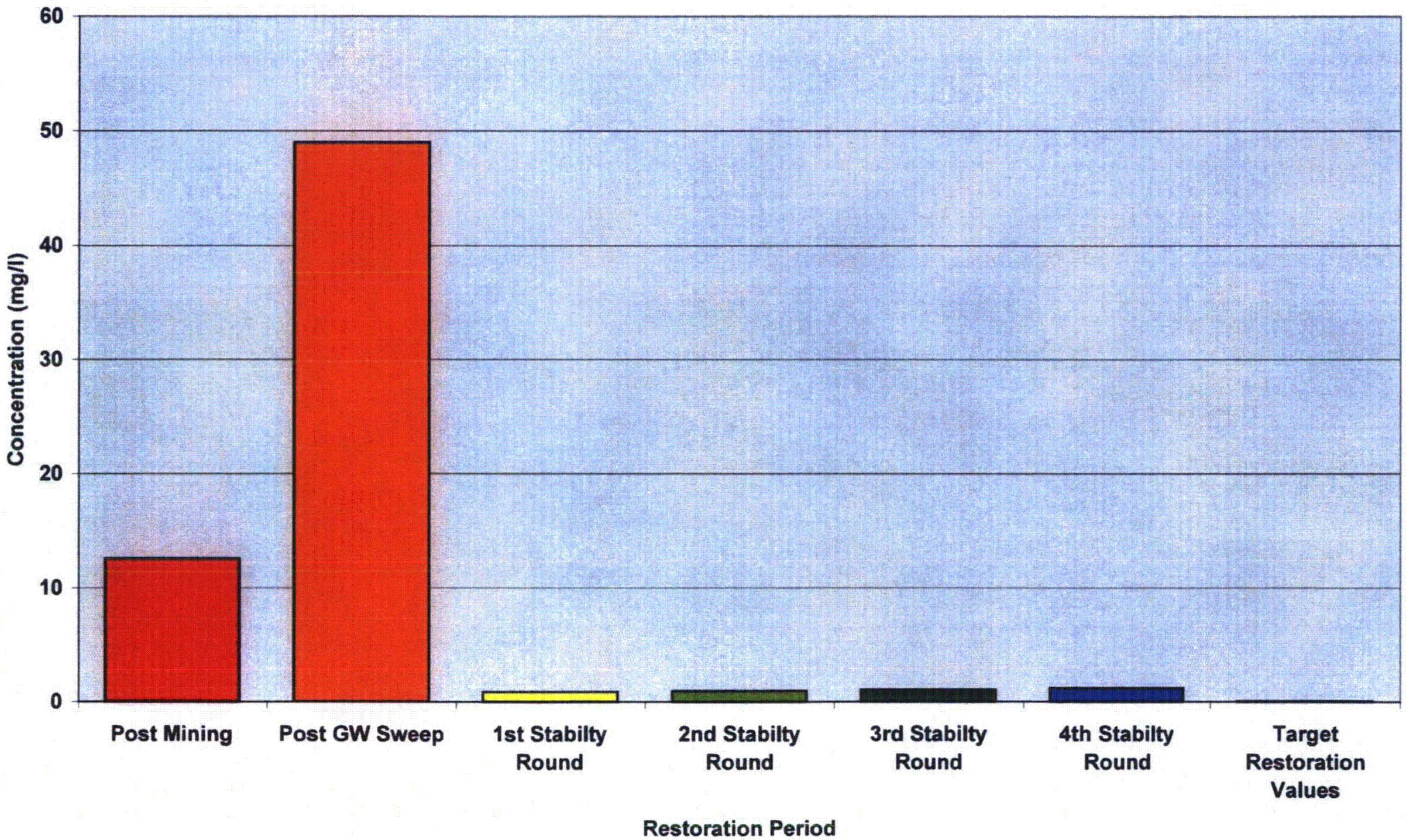
Cogema Mining, Inc., Wellfield Restoration Report Christensen Ranch Project Wyoming, March 2008.

**Figure 6-A-4 Mean Uranium Concentration-Post Mining Through 4th Stability Round
Mine Unit 5, Christensen Ranch, Wyoming, Cogema Mining, Inc..**



Cogema Mining, Inc., Wellfield Restoration Report Christensen Ranch Project Wyoming, March 2008.

Figure 6-A-5 Mean Uranium Concentration-Post Mining Through 4th Stability Round
Mine Unit 6, Christensen Ranch, Wyoming, Cogema Mining, Inc.



Cogema Mining, Inc., Wellfield Restoration Report Christensen Ranch Project Wyoming, March 2008.

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7 ENVIRONMENTAL EFFECTS

This section discusses and describes the degree of unavoidable environmental impacts that will be associated with construction and operations of the proposed Ludeman Project (proposed project). Environmental impacts can be direct, indirect, and/or cumulative in nature and can be temporary (short term) or permanent (long term).

7.1 POTENTIAL ENVIRONMENTAL EFFECTS OF SITE PREPARATION AND CONSTRUCTION

The site preparation and construction associated with the proposed project will include the following activities:

- Construction of three Satellite facilities;
- Construction of deep injection well(s) and associated surge ponds; and
- Grading and construction of access roads, as required.

Site preparation and construction activities for installations other than wellfields will include topsoil salvaging, site clearing and leveling, building erection, and access road construction. The impacts from wellfield construction activities, including the construction of injection, production, and monitor wells, are discussed in Section 7.2 since these are ongoing activities at an ISR facility. This section strictly discusses the short-term impacts of initial site preparation and facility construction where they differ from the impacts of operations.

Environmental impacts of construction projected for the proposed project are based on the baseline studies of the existing environment conducted by Uranium One and presented and discussed in Section 2 of this document. The total area impacted by initial construction of three Satellite facilities with associated surge ponds is approximately 15 acres. All areas disturbed will be reclaimed during final decommissioning activities as described in Section 6 of this TR. The planned schedule for construction, production, restoration, and decommissioning is presented in Section 1 of this document.

7.1.1 Potential Air Quality Effects of Construction

Construction activities at the proposed project will cause minimal short-term effects on local air quality. Increased suspended particulates from vehicular traffic on unpaved roads, fugitive dust caused by wind erosion of areas cleared of vegetation, and diesel emissions from construction equipment would be the primary potential air quality impacts. The application of water to unpaved roads will reduce the amount of fugitive

dust to levels equal to or less than the existing condition. Diesel emissions from construction equipment are expected to be short term only, ceasing once the operational phase begins.

7.1.2 Potential Land Use Impacts of Construction

As discussed in Section 2.2, rangeland and wildlife habitat is the primary land use within the proposed project area and the surrounding two-mile review area. Natural gas pipeline facilities and infrastructure along with a wind farm are also located on rangeland within the review area. There is one occupied housing unit within the proposed project area. Figure 2.2-2 of this TR depicts land use in the review area.

Construction of the three proposed project ion exchange Satellite facilities and associated structures (including surge ponds) will encompass approximately 15 acres (5 acres each). As a result of site preparation and construction, rangeland land use will be excluded from the area that is under development as an ISR unit. Gas transportation facilities will not be affected. Considering the relatively small size of the area impacted by construction, the exclusion of grazing from this area over the course of the proposed project will have a minimal impact on local livestock production. These potential impacts to land use are considered temporary and reversible by post-operation surface reclamation, returning the land to unrestricted use, including its former grazing use.

7.1.3 Potential Surface Water Impacts of Construction

Construction activities for the proposed project Satellite facilities and the access roads have the potential to temporarily increase the sediment yield of the disturbed areas. The impacted area during construction of the proposed project Satellite facilities will be relatively small in comparison to the overall area that will be impacted during wellfield construction. Therefore, potential surface water impacts from sedimentation are discussed in Section 7.2.6.2. A Storm Water Pollution Prevention Plan (SWPPP) will be developed and implemented with oversight by the WDEQ, to address all storm water drainage impacts from erosion and sedimentation during proposed project construction activities.

7.1.4 Potential Population, Social, and Economic Impacts of Construction

The construction and decommissioning phases of the proposed project will cause a moderate impact to the local economy, resulting from the purchases of goods and services directly related to construction activities and increased demand for housing and other services. Potential impacts to community services such as roads, housing, schools and energy costs would be minor in the nearby towns of Rolling Hills (a small town located west of the proposed project on State Highway 95), Glenrock (west on State

Highway 95), Douglas (southeast on State Highway 93), and Casper (the nearest regional economic hub).

In the first year, project development will be construction only and will create approximately 65 jobs directly related to construction activities. Based on local experience, an estimated 50 percent of the peak year construction/decommissioning workforce would be persons already living in Converse County and Natrona County. Other workers may come from outside the local area and will either re-locate for the term of the project or will be long-distance commuters working for extended shifts.

Most construction work available to the local construction labor pool consists of temporary contract work that varies in duration, depending on the scope of each construction project. Further, the number of unemployed construction workers does not represent the number of workers that would be available to the proposed project from the local construction labor pool. The number is an annual average that does not take into account monthly variations in the available construction labor pool from construction start-ups and completions. Contractors for projects located in central Wyoming typically hire the local construction labor pool. The actual number of construction workers available for the proposed project would potentially draw from the Converse County and Natrona County construction combined labor pool of 3,142 (January, 2009 Wyoming Department of Employment).

7.1.5 Potential Noise Impacts of Construction

Open rangeland is the primary land use within and in the surrounding two-mile area with the exception of the rural Negley subdivision one half mile north of the Leuenberger Satellite facility and a wind farm located approximately 1.5 miles west of the proposed project boundary. Other land uses include natural gas transportation facilities. The existing ambient noise in the vicinity of the proposed project is dominated by the traffic noise from State Highways 95 and 93 and surrounding oil and gas operations.

The proposed Leuenberger Satellite facility site is approximately one half mile from the property boundary of the small rural Negley Subdivision and approximately one mile from the Leuenberger Ranch house. Assuming that the noise level produced by unshielded machinery at the facility site is 85dB at 50 feet, the sound pressure level attained at the property boundary will be below the level identified by the USEPA as suitable for outdoor areas where human activity takes place (approximately 55 dB[1]). A level of 85 dB is the OSHA threshold at which a hearing conservation program at the plant would be required. Experience at operating ISR facilities verifies that this assumption is conservative and that the average sound pressure levels during construction will be less than 85 dB. After appropriate engineered controls (i.e. the protective enclosure for the equipment) are installed, noise levels will not impact the residences, and

are unlikely to approach the levels attained by State Highway 95. Therefore, impact to noise or congestion above ambient background noise within the proposed project area or in the surrounding two-mile area is not anticipated.

As a result of the remote location of the proposed project and the relatively low population density of the surrounding area, potential impacts to noise or congestion above ambient background noise within the proposed project area or in the surrounding two-mile area are not anticipated. Additionally, given the maximum increase in population due to migrant workers is insignificant, noise and congestion impacts are not anticipated in Glenrock, Rolling Hills or other neighboring towns or counties.

7.2 POTENTIAL ENVIRONMENTAL EFFECTS OF OPERATIONS

This section describes the potential environmental impacts of operation of the proposed project. Operational activities will include the following:

- Ongoing wellfield construction activities including well drilling and construction, access road construction, installation of pipelines and utilities, and construction of headerhouses;
- Facility and wellfield production operations;
- Groundwater restoration activities as wellfields are removed from production; and
- Final site decommissioning and reclamation activities.

Potential environmental concerns from the operation of the proposed project are addressed in the following sections: potential air quality impacts, potential land use and water quality impacts, potential soil impacts, potential impacts to cultural resources, potential ecological impacts, and potential cumulative impacts from existing natural gas pipeline facilities within the proposed project area.

7.2.1 Potential Air Quality Impacts of Operations

Uranium One estimated fugitive dust emissions from operation of the proposed project area based on projected activity levels and using emission factors supplied by the WDEQ. Projected activities impacting dust emissions included ongoing wellfield construction activities, routine site traffic related to operations and maintenance, heavy truck traffic delivering chemicals and material and shipping product, and employee traffic to and from the site. Based on these activities, the projected total PM_{10} emissions is 15.5 tons per year. This level of emissions is small relative to surface mines and other industrial operations that generate dust from vehicles and disturbed areas.

The larger surface mines in the Powder River Basin show PM_{10} emissions inventories in the thousands of tons per year. Sections of unpaved county roads can also exceed 15 tons per year emission rate by an order of magnitude or more. Viewed another way, atmospheric dispersion modeling generally shows that fugitive PM_{10} emissions on the order of 15 tons per year result is an insignificant impact to ambient air beyond a distance of a few hundred yards from the sources. 40 CFR 51.165(b)(2) defines the Significant Impact Level (SIL) for PM_{10} as 1.0 $\mu g/m^3$ or more. For reference purposes, 40 CFR 50.6(a) defines the national ambient standard for annual average PM_{10} as 150 $\mu g/m^3$.

It is not anticipated that there will be any significant potential impacts regarding radiological particulate emissions from the Satellite facilities operations. Radiological gaseous emissions anticipated during operation are described in Section 7.3.

It is important to note that no control factors were assumed for the emission calculations. This is a conservative effect resulting in overestimation of dust generation as periodic watering or chemical treatment of the unpaved roads will reduce emission factors by half or more.

7.2.2 Potential Land Use Impacts of Operations

As discussed in Section 2.2 and 7.1.2 of this TR, open rangeland is the primary land use within and in the surrounding two-mile area with the exception of the rural Negley subdivision one half mile north of the Leuenberger Satellite facility and the Top of the World wind farm located approximately 1.5 miles west of the proposed project boundary. Other land uses include natural gas transportation facilities. There is one occupied housing unit in the proposed project area. The existing ambient noise in the vicinity of the proposed project is dominated by the traffic noise from State Highways 95 and 93 and surrounding oil and gas operations.

The wellfields, three Satellite facilities for ion exchange columns, resin transfer facilities, pumps for injection of lixiviant, and up to six surge ponds and six deep disposal wells are the significant surface features associated with the proposed project ISR operations. Construction of the three Satellite facilities and associated structures will encompass approximately 15 acres. The Satellite facilities are anticipated to consist of an 80- x 140-foot processing building, associated parking, and other infrastructure within an approximate 1.5 acre area enclosed with security fencing. In addition, two surge ponds (each approximately 1.2 acres) will be separately enclosed in a 3.5 acre area with security fencing. The road disturbance acreage is approximately 37 acres and is calculated assuming approximately seven miles of 25-foot-wide main road and approximately 18 miles of eight-foot-wide, field roads. The total surface area of the proposed project to be affected by the proposed operation is estimated to total 815 acres.

The proposed total wellfield area to be used for the injection and recovery of solution over the thirteen-year mine life (not including construction and decommissioning) will be approximately 763 acres. Active wellfields and those in restoration will be fenced to limit access by livestock to wellfield areas and will be slightly greater than that encompassed by the areas to be mined. Natural gas pipeline facilities will not be affected. Considering the relatively small size of the area impacted by operations, the exclusion of grazing from this area over the course of the proposed project will have an insignificant impact on local livestock production.

7.2.3 Potential Geologic and Soil Impacts of Operations

7.2.3.1 Potential Geologic Impacts of Operations

Geological impacts from operations are expected to be minimal, if any. No significant matrix compression or ground subsidence is expected, as the net withdrawal of fluid from the target sandstone will be on the order of one percent or less. Further, once mining and restoration operations are completed, groundwater levels will return to near-original conditions under a natural gradient.

7.2.3.2 Potential Soil Impacts of Operations

Based on the soil mapping unit descriptions in Section 2.6 of this document, the hazard for water erosion within the proposed project area varies from slight to severe and the hazard from wind erosion varies from moderate to severe. The potential for wind and water erosion is mainly a factor of surface characteristics of the soil, including texture and organic matter content. General topography of the area ranges from nearly level uplands to very steep hills, ridges and breaks of dissected shale plains. The soils occurring on the proposed project were generally a sandy or coarse texture throughout upland areas and fine, clay textured soils occurring in or near drainages. The proposed project area contained deep soils on level upland areas with shallow and very shallow soils located on hills, ridges and breaks. Given the texture of the surface horizons throughout the majority of the proposed project area and the semi-arid climate, the soils are more susceptible to erosion from wind than water. See Table 2.6-8 in Section 2.6 for a summary of wind and water erosion hazards within the proposed project.

The three Satellite facility locations are underlain by soils with a slight potential for water erosion and a severe potential for wind erosion. The soils underlying the proposed wellfields are at a moderate to severe risk of erosion from both wind and water. Though no topsoil will be stripped from the wellfields, construction may result in an increase in the erosion hazard from both wind and water due to the removal of vegetation and the physical disturbance from heavy equipment.

Soil erosion mitigation will be implemented in accordance with WDEQ-LQD Rules and Regulations, Chapter 3, Environmental Protection Performance Standards. Typical erosion protection measures that may be implemented at the proposed project include the following:

- Temporary diversion of surface runoff from undisturbed areas around the disturbed areas and the use of water velocity dissipation structures;
- Retaining sediment within the disturbed areas through the use of best management practices such as silt fencing, retention ponds, or other effective means; and
- Salvage and stockpiling of topsoil from the proposed project Satellite facility areas and from secondary wellfield access roads in a manner to avoid wind and/or water erosion.

7.2.4 Potential Archeological Resources Impacts of Operations

As discussed in Section 2.4 of this TR, a Class III cultural resource inventory of the proposed project was conducted in 2008 by Ethnoscience, Inc. of Billings Montana. The inventory incorporated 19,888 acres, of which 398 acres are under Bureau of Land Management jurisdiction, 1,485 acres are owned by the State of Wyoming, and remaining 18,005 acres are privately owned. The investigation identified 47 sites and 59 isolated finds. Three previously recorded prehistoric sites within the proposed project area were not found. It is assumed they no longer exist. Historic documents also note the possible presence of a historic telegraph line, but the inventory identified no evidence of this site.

Twenty-four of the sites are prehistoric. All of the existing sites are archaeological. Eighteen of the prehistoric sites contain stone features. Two sites are culture material scatters and six are lithic scatters. No other class of artifacts was found.

Twenty-three sites are historic. The historic sites consist of a historic trail (Bozeman Trail), five windmills, five farmsteads, three foundations, three depressions, four culture material scatters, and two stone features. The stone feature consists of a historically formed rock pile. Its function is unknown.

The Bozeman Trail is listed on the National Register. The ruts associated with this trail in the proposed project area are shallow and difficult to see. The setting associated with the Bozeman trail within the proposed project area is impacted by the construction of Highway 93, located between 0.5 to 0.25 mile to the east and northeast, a fence line along the highway, and the construction of a dam and stock pond immediately to the east of the trail. As such, the portion of the trail located within the proposed project area is no longer able to convey its original character as a frontier trail. Because of the lack of setting and

feeling, the segments of the trail within the proposed project area are recommended as not contributing to the site's eligibility for listing on the National Register.

The remaining sites were examined to ascertain their eligibility for listing on the National Register. The method used to provide recommendations regarding National Register eligibility closely follows the guidelines established by the Department of the Interior. Of particular importance are National Register Bulletins 15 and 16 (National Park Service [NPS] 1991a and 1991b). According to these bulletins, a property must possess historic significance and integrity to be listed on the National Register. With the exception of windmills, sites identified in the proposed project area consist of archaeological remains. This limits the potential eligibility of sites. Isolated Finds are rarely, if ever, recommended National Register eligible.

Based on the site's historic significance, and surface observations of integrity and soil deposition, 37 of the sites are recommended ineligible for listing on the National Register of Historic Places (National Register). Three additional sites are recommended ineligible based on the results of subsurface testing. The National Register status of the remaining six sites cannot be determined without further investigation.

As concluded in the Class III Inventory Report, provided in Appendix B, the currently proposed project will not affect any known significant cultural resources and additional archaeological work is not considered necessary.

The discovery of cultural artifacts in an operational area shall result in a work stoppage in the vicinity of the find until the resources can be evaluated by a professional archaeologist. Mitigation measures that will be implemented if future development expands near any eligible sites are discussed in Section 5.8 of the ER.

7.2.4.1 Potential Effects to Visual Resources

The visible surface structures proposed for the proposed project include wellhead covers, header houses, electrical distribution lines, booster pump houses, and three Satellite facilities. The project will use existing and limited new roads to access the Satellite facilities and each header house.

Each wellhead cover typically consists of a weatherproof structure placed over the well. These covers are approximately three feet high and two feet in diameter. Each header house is a small metal building. A disturbance area around each header house is necessary to provide an adequate area for operations and maintenance vehicles to turn around. Each Satellite facility is anticipated to consist of an 80- x 140-foot processing building, associated parking, and other infrastructure within an approximate 1.5 acre area enclosed with security fencing. In addition, two surge ponds (each approximately 1.2

acres) will be separately enclosed in a 3.5 acre area with security fencing. Electric distribution lines will connect header houses and Satellite facility to existing electric distribution lines and will be buried when possible. The distribution poles will be approximately 20 feet high and will be wooden so that their natural color harmonizes with the landscape. Road disturbance acreage is calculated assuming approximately seven miles of 25-foot-wide main road and approximately 18 miles of eight-foot-wide, field roads.

Temporary and short-term visual effects during the construction period in each wellfield will result from header house construction, well drilling, and construction of access roads and electric distribution lines. Following completion of wellfield installation, temporarily disturbed areas will be reclaimed. Only long-term effects associated with operations and maintenance will remain following post-construction reclamation.

Potential short-term effects will result from the addition of structures to the landscape, such as the Satellite facilities and associated structures, header houses, wellhead covers, access roads, and electric distribution lines. Potential effects from short-term activities will occur over the life of the project.

The most important visual resource areas include:

- Public views from Highways 93 and 95 and from Country Roads 26 and 27 (Leuenberger Road and Tank Farm Road);
- Views from the subdivision adjacent to the northwest project boundary;
- Views from the Leuenberger ranch house;
- Views from the North Platte River; and
- Portions of the Bozeman Trail accessible to the general public.

Wellfields with associated wellheads and header houses will be visible from public roadways, the subdivision, and will be adjacent to the Bozeman Trail. Wellhead covers will be approximately 3-feet tall and header houses will be approximately 10-feet high at the eave; both will be painted to blend with the surrounding environment. Within the proposed project area, there are currently three industrial sites visible from the public roadways. The portions of the industrial sites that are painted to blend with the surrounding environment are not as easily discerned as those painted white or dark brown.

The locations for the three Satellite facilities were chosen to minimize visibility of those facilities as a result of existing topography. The Leuenberger Satellite facility site will be the site most visible to the public. Its proposed location in Section 14 (T34N R74W) at an elevation of 5260 feet and approximately one-half mile south of Highway 95 will be partially visible from the highway and from the subdivision adjacent to Highway 95. A

small bluff at an elevation of 5,260 feet is located between the subdivision and the proposed plant site which will partially block the view from the subdivision. A line-of-sight diagram from the subdivision to the proposed plant is provided in Addendum 2.4-A. There is currently an industrial building with two outlying tanks within the same section of land (Leuenberger Pilot Plant Building) which are located closer, and are more visible to the subdivision than the proposed Satellite facility.

The proposed North Platte Satellite facility site is located in Section 10 (T34N R73W) at an elevation of 5,320 feet. There is a hill to the east of the North Platte facility site with an approximate top elevation of 5,372 feet. The hill will block the view of the plant from Highway 93 and the Bozeman Trail which is approximately one mile northeast of the plant site. There are hills to the northwest of the North Platte Satellite facility site with a maximum elevation of approximately 5,340 feet which will limit, if not completely block, the view of the plant from Highway 95. A line-of-sight diagram from Highway 93 to the proposed plant is provided in Addendum 2.4-A.

The proposed Peterson Satellite facility is located in Section 26 (T34N R73W) at an elevation of approximately 5,110 feet. The facility site will be on top of a bluff and approximately two miles north of the North Platte River which is at an elevation of approximately 4900 feet. The distance combined with the elevation difference should effectively limit views of the facility from the river. The facility is approximately 1.25 miles north of Tank Farm Road. Tank Farm Road is at an elevation of approximately 4,910-feet. As with the river, the distance and the difference in elevation should effectively shield the plant from view. A line-of-sight diagram from the North Platte River to the proposed plant is provided in Addendum 2.4-A.

The views from the Leuenberger ranch house should not be affected. The closest wellfield will be just over one-half mile west of the ranch house. A hill exists between the ranch house and the proposed wellfield which will shield the view of the wellfield. The next closest wellfield is approximately 1.5 miles to the southeast. The rolling topography between the wellfield and the ranch house will shield the view of the wellfield.

As discussed above, if the visual resource evaluation rating of a proposed project area is 19 or less, no further evaluation is required by NUREG-1569 (NRC, 2003). Based on field reconnaissance conducted in June and August 2008, the total score of the scenic quality inventory for the Ludeman Project is 11. Therefore, no further evaluation of existing scenic resources and any changes to scenic resources from proposed project facilities are required. However, Uranium One intends to continue to adopt measures to lessen the visual impact of the project.

Mitigation measures are meant to minimize adverse contrasts of project facilities with the existing landscape. The measures should be applied to all facilities, even those that meet

VRM objectives. Mitigation would enable proposed project facilities to harmonize with the surrounding landscape to the extent feasible.

Uranium One's additional measures are meant to minimize adverse contrasts of project facilities with the existing landscape. All installed above-ground wellheads and structures will be painted with low reflectivity paint in colors that harmonize with the surrounding landscape. In addition, several design techniques will be implemented to minimize the visual contrasts. Those methods include reducing unnecessary disturbance by using the same trench for multiple utilities, reducing the area of temporary disturbance by designating equipment parking areas during construction, and following areas of existing disturbance when considering utility placement. To the extent possible, topographic features will be used to screen facilities and roads from public view. Roads may be aligned with the contours of the topography, although this measure may result in a greater area of disturbance. Construction debris will be removed from new construction areas as soon as possible and temporarily disturbed areas will be reclaimed as soon as possible following construction.

In general, resource protection measures proposed for erosion control, road construction, rehabilitation and re-vegetation would mitigate effects to visual quality.

The dominant feature of the landscape are the 268 wind turbines located 1.5 miles to west of the project boundary. The wind turbines are approximately 400 feet in height and are spaced approximately 750 feet apart in multiple rows over 15 miles. These structures are visible at night due to the lighting requirements by the Federal Aviation Administration (FAA) on all structures over 200 feet high. These requirements can range from white strobes to red flashing lights.

7.2.5 Groundwater Impacts of Operations

The potential groundwater impacts of ISR production are related to the consumption of groundwater and short- and long-term changes to groundwater quality within the ore body. Impacts of groundwater consumption are described in Section 7.2.5.1. Perhaps the most significant environmental impact that could occur as a result of ISR mining is the degradation of water quality in the ore-bearing aquifer. These potential impacts are discussed in Section 7.2.5.2. Potential groundwater impacts resulting from accidents and spills are described in Sections 7.2.5.3 and 7.2.5.4.

7.2.5.1 Groundwater Consumption

Based on a bleed of 0.5 percent to 1.5 percent which has been successfully applied during mining at other ISR operations, the potential impact from consumptive use of groundwater is expected to be minimal. In this regard, the vast majority (e.g., on the order

of 99 percent) of groundwater used in the mining process will be treated and re-injected. Potential impacts on groundwater due to consumptive use outside the proposed project area are expected to be negligible.

To assess the impacts from mining and restoration operations on local groundwater, the following monitoring will be performed:

- Measure background water levels in selected private domestic or livestock water wells surrounding the project area before mining and every three months during operation; and
- Measure background water levels in regional monitoring wells installed by Uranium One before mining and every three months during operations.

In the unlikely event that impacts to either the adjacent domestic wells or to stock wells in the vicinity of the proposed project are observed (e.g., water levels drop to a point that impairs the usefulness of the wells) and determined to be a result of the project, the following mitigation measures would be considered:

- Lowering the pump level in the wells, if possible;
- Deepening the wells, if possible; or
- Replacing the wells with new wells completed in deeper sands that are not impacted by ISR operations.

7.2.5.2 Potential Impacts on Production Zone Groundwater Quality

During ISR operations, water quality impacts are usually of greater concern than water consumption impacts because water consumption during mining is relatively small. Impacts to groundwater from the proposed lixiviant is caused by (1) the addition of sodium bicarbonate and or carbon dioxide and oxygen to the groundwater, (2) the addition of chloride to the groundwater by the processing plant, and (3) the interaction of these chemicals with the mineral and chemical constituents of the aquifer being mined. The result is that during mining, the concentration of most of the naturally occurring dissolved constituents in the mining zone will be appreciably higher than their concentrations in the original groundwater.

Uranium One has estimated the post-mining water quality based on the experience of COGEMA Mining, Inc. (Cogema, 2004) in Production Units 1 through 9 at the Willow Creek ISR project located in the Powder River Basin near the proposed Ludeman Project as described in Section 6.1.2. The Willow Creek data was selected because of the availability of extensive quantities of relevant data, its general proximity to and similar geologic conditions to the proposed project. COGEMA employed ammonium

bicarbonate with hydrogen peroxide as the oxidant during early mining operations. In May 1980, the lixiviant system for the entire site was converted to sodium bicarbonate chemistry with gaseous oxygen as the oxidant. The water quality database is extensive because it represents nine production units located in a 30-acre site.

The water quality of the Willow Creek Production Zone after mining was established by sampling each of the designated restoration wells. The post-mining mean of the analytical results from Production Units 1 through 9 is presented in Table 6-2. The chemical alteration of the Production Zone aquifer can be observed through comparison of the post-mining mean concentrations with the baseline concentrations. Uranium One expects similar baseline and post-mining water quality at the proposed project.

While it is likely that the wells within and surrounding the proposed project area may provide stock water for private or public (BLM) leases, none are located in currently proposed mining areas and may not be completed in the ore bearing aquifer where mining will occur. If future mine development includes an area(s) where a stock well is located in an aquifer to be mined, the following mitigation measures would be considered:

- Replacing the wells with new wells completed in either shallower or deeper sands that are not impacted by ISR operations; or
- Providing another source of stockwater

7.2.5.2.1 Negley Subdivision Water Wells

The Negley development is an unincorporated subdivision consisting of approximately 30 individual land owners located in Section 11, T34N, R74W (shown in Figure 7.2-1). The Negley Subdivision is located within two miles of the proposed project northern boundary. Twenty water wells have been identified in Section 11 of the subdivision, and three nearby wells, one located in each of Section 1 (Well N-9), Section 2 (Well N-11) and Section 9 (Well N-8), T34N, R74W, all of which have been grouped into the Negley well category. Table 7-3 provides the Negley well information and Figure 7-1 shows the locations of the wells. The Negley wells have been sampled for baseline water quality and the data summaries are found in Section 2.7, Addendum 2.7-E. The assessment of the hydraulic relationship of the Negley subdivision to the proposed Ludeman ISR Uranium project can be seen in Addendum 2.7-F.

Available information indicates that the water wells in the Negley Subdivision are in aquifers that lie above the proposed Ludeman Project Production Zones and therefore the proposed ISR production will not occur in the same zones in which the Negley wells are completed. Additionally, the proposed project Production Zone aquifers are separated from the Negley wells aquifers by approximately 100 feet of claystone that has shown to be a hydrologic confining layer through historic and recent pumping tests conducted in

the Leuenberger area (described in Section 2.7). As a result, ISR production at the proposed project are not anticipated to have an impact on the water quality of the Negley wells.

Historical Background

In-situ recovery related mining activities occurred in the late 1970's and early 1980's on the Leuenberger Ranch, located south of the Negley Subdivision in Section 14. Figure 7.2-1 shows the location of the Leuenberger pilot project site, which was licensed by the NRC (Source Material License No. SUA-1371, Docket No. 40-8728) and permitted by the WYDEQ-LQD to Teton Exploration Drilling Co., Inc. (Teton) for License to Explore (LE103), which was replaced by a Research and Development License (2RD), and subsequently replaced by commercial scale Mine Permit 552. A review of the operator history, project activities and permitting history of the Leuenberger pilot project is outlined in a WYDEQ-LQD memorandum (WYDEQ-LQD, 2000).

The Production Zones tested (including well designs, operations, restoration) at the Leuenberger site were in the "M" (80) Sand and the "N" (90) Sand, both of which are considered Production Zone targets of the proposed project in the area of the former Leuenberger site. The underlying aquifer was considered the "L" (70) Sand. (Note: Uranium One geologic nomenclature and a stratigraphic column describing the geologic units at the proposed project are included in Section 2.6). The 80 Sand is about 320 to 390 feet below surface and is separated from the overlying 90 Sand by about 50 to 75 feet of claystone and siltstone. The 80 Sand ranges from about 50 to 65 feet in thickness. The 90 Sand, which was the shallowest sand tested at this site, occurs about 220 to 270 feet below surface and is about 50 feet thick. The overlying aquifer, referred to as the "Idaho Sand" or "O" (interpreted as the 100 Sand in the region, and as the 110 Sand in the immediate vicinity of the Leuenberger test site where the 100 Sand is absent), was determined to be the uppermost ground water aquifer and the common domestic water source at the adjacent areas. This shallow aquifer is separated from the 90 Sand by about 100 feet of claystone.

During the Leuenberger pilot project, baseline monitoring of ground water quality from monitor wells in the overlying, Production Zone and underlying aquifers was conducted in the pilot project area. Two off-site monitor wells were completed in the overlying aquifer. Based on available site information, data interpretation, and the limited duration and magnitude of mining activities at the Leuenberger pilot plant, it was concluded that there were no impacts to the shallow aquifer in which most domestic wells in the area were completed. (WYDEQ-LQD, 2000).

Figure 7-1: Negley Subdivision Water Well Locations

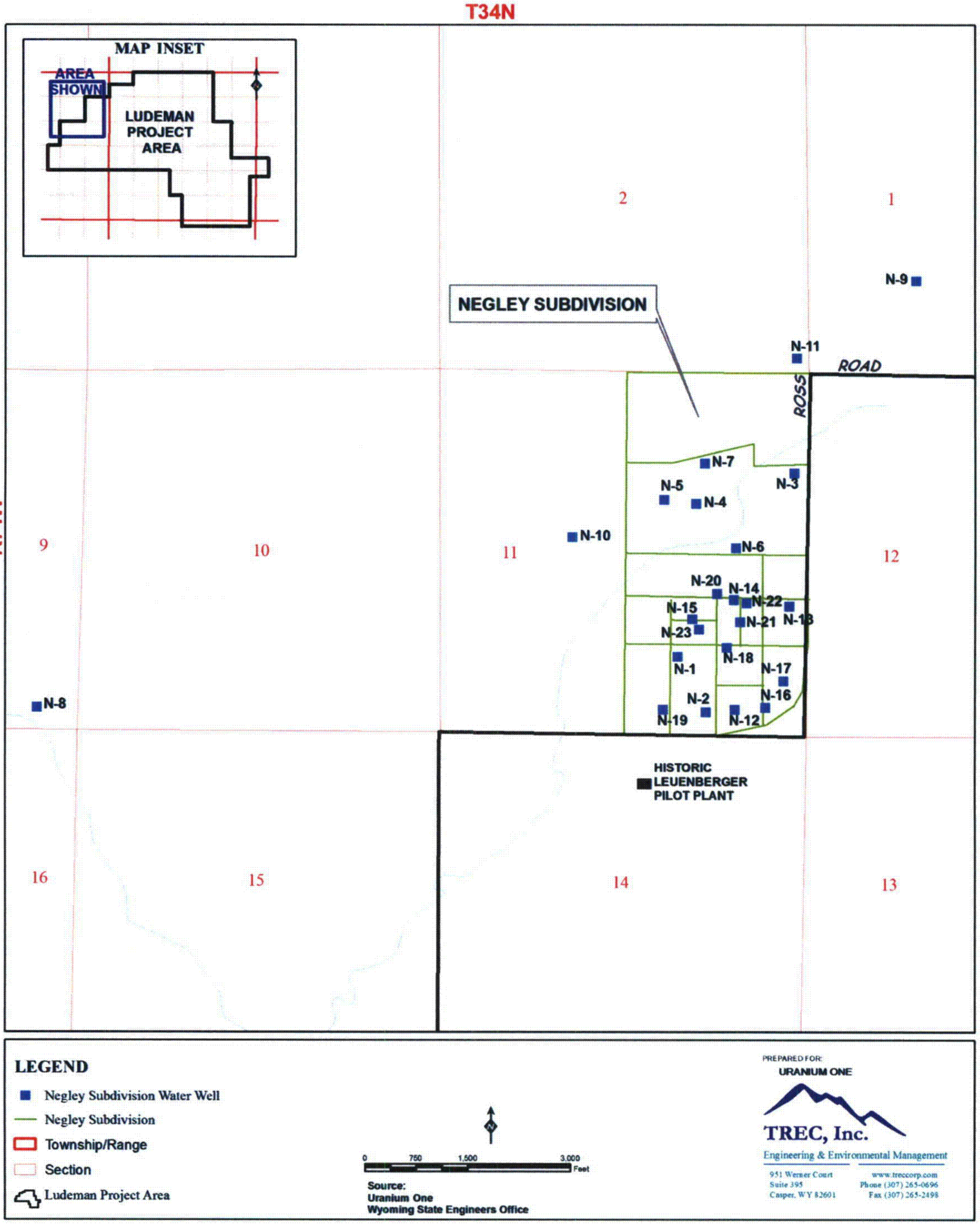


Table 7-1: Negley Subdivision Well Information

Well No.	Elevation (ft)	Latitude North	Longitude West	Casing ID	TD (ft)
N-1	5262	42°55.674	105°41.904	5"	129
N-2	5255	42°55.543	105°41.812	5"	80
N-3	5277	42°56.116	105°41.529	5"	120
N-4	5269	42°56.042	105°41.849	5"	200
N-5	5307	42°56.051	105°41.952	5"	200
N-6	5260	42°55.936	105°41.717	5"	180
N-7	5290	42°56.138	105°41.821	6"	300
N-8	5215	42°55.541	105°43.994	10"	300
N-9	5371	42°56.581	105°41.137	5"	135
N-10	5237	42°55.959	105°42.251	5"	60
N-11	5310	42°56.392	105°41.524	5"	n.a.
N-12	5288	42°55.550	105°41.717	5"	n.a.
N-13	5293	42°55.798	105°41.542	5"	210
N-14	5272	42°55.812	105°41.722	6"	172
N-15	5258	42°55.766	105°41.857	5"	n.a.
N-16	5281	42°55.555	105°41.617	6"	175
N-17	5261	42°55.618	105°41.559	5"	n.a.
N-18	5252	42°55.698	105°41.745	5"	200
N-19	5214	42°55.548	105°41.951	5"	n.a.
N-20	5289	42°55.827	105°41.777	5"	n.a.
N-21	5285	42°55.760	105°41.702	5"	n.a.
N-22	5265	42°55.806	105°41.682	5"	210
N-23	5260	42°55.741	105°41.836	5"	165

n.a. = Information not available from WSEO

Current Analysis

Water quality data summaries for the Negley wells are located in Section 2.7, Addendum 2.7-E. Based on available well data, geologic information and historic pilot plant operations, the ISR operations at the proposed project are not anticipated to have an impact on the water quality of the wells in Negley Subdivision. It is possible that N-8 is completed in a Production Zone Aquifer, it is located approximately 1.6 miles west of the Negley Subdivision and 1.1 miles from the western proposed project boundary. Uranium One will continue to perform baseline operational monitoring as required by the NRC..

7.2.5.3 Potential Groundwater Quality Impacts from Accidents

7.2.5.3.1 Lixiviant Excursions

Excursions of lixiviant at ISR facilities have the potential to impact adjacent aquifers with radioactive and trace elements that have been mobilized by the mining process. These excursions are typically classified as horizontal or vertical. A horizontal excursion is a lateral movement of mining solutions outside the mining zone of the ore-body aquifer. A vertical excursion is a movement of solutions into overlying or underlying aquifers.

Water quality impacts in adjacent aquifers from ISR mining activities are related to the identification, control, and clean-up of excursions. During production, injection of the lixiviant into the wellfield results in a temporary degradation of water quality compared to pre-mining conditions. Movement of this water out of the wellfield results in an excursion. Excursions of impacted groundwater in a wellfield can result from an improper balance between injection and recovery rates, undetected high permeability strata or geologic faults, improperly abandoned exploration drill holes, discontinuity and unsuitability of the confining units which allow movement of the lixiviant out of the Production Zone, poor well integrity, or hydrofracturing of the Production Zone or surrounding units. Past experience from other commercial scale ISR projects in the Powder River Basin has shown that when proper steps are taken in monitoring and operating a wellfield, excursions, if they do occur, can be controlled and recovered such that serious impacts to groundwater quality are prevented.

Accident Prevention and Mitigation is discussed with more detail in section 7.5.3.1.

7.2.5.3.2 Potential Groundwater Quality Impacts from Spills

Potential impacts to groundwater and surface water may occur during operations as a result of an uncontrolled release of process liquids due to a wellfield leak. Should an

uncontrolled wellfield release occur, there would be a potential impact of the shallow aquifer as well as surrounding soil. With a slow leak that remains undiscovered or a catastrophic failure, a shallow excursion is one potential impact. In this unlikely event, wells could be installed in the effected shallow aquifer and pumps used to capture and eliminate the impacted water.

The rupture of an injection or recovery line in a wellfield, or a trunkline between a wellfield and the plant, would result in a release of injection or production solution which would impact the ground in the area of the break.

Occasionally, small leaks at pipe joints and fittings in the header houses or at the wellheads may occur. Until remedied, these leaks may drip process solutions onto the underlying soil. These leaks seldom result in soil contamination. Uranium One will implement a program of continuous wellfield monitoring by roving wellfield operators and will require periodic inspections of each well that is in service. Small leaks in wellfield piping typically occur in the injection system due to the higher system pressures. These leaks seldom result in soil contamination. Following repair of a leak, Uranium One will require that the affected soil be surveyed for contamination and the area of the spill documented. If contamination is detected, the soil is sampled and analyzed for the appropriate radionuclides. Impacted soils may be removed as appropriate.

7.2.6 Potential Surface Water Impacts of Operations

7.2.6.1 Surface Waters and Wetlands

Uranium One plans to construct three Satellite facilities and associated well fields at the proposed project. No perennial streams or other permanent water bodies exist within the proposed project area. The majority of the area is drained to the east by Sage Creek and its tributaries. Little Sand Creek drains the western portion of the site. All natural flow in the region is categorized as intermittent or ephemeral and all, if not impounded, eventually drains to the North Platte River to the south. A number of stock tanks and reservoirs were scattered throughout the area, though the reservoirs rarely contained water. A wetland survey was conducted within the entire proposed project site area in accordance with the Interim Regional Supplement to the 2008 U.S. Army Corps of Engineers (USACE) Wetland Delineation Manual: Great Plains Region. Identification of potential wetlands was based on visual assessment of vegetation and hydrology indicators, as well as intrusive soil sampling to determine the presence of wetland criteria indicators. Hydrology and soils were evaluated whenever a plant community type met hydrophytic vegetation parameters based on the Dominance Test and Prevalence Index (as defined by the USACE Great Plains Regional Supplement), or whenever indicators suggested the potential presence of a seasonal wetland area under normal circumstances.

Per the Great Plains Interim Regional Supplement, for wetland delineation purposes, an area is considered to be vegetated if it has five percent or more total plant cover at the peak of the growing season.

Construction, operation, or reclamation activities, which cause disturbance or impacts to jurisdictional wetlands on the proposed project, will be performed in accordance with appropriate Nationwide Permits (NWP), if applicable:

- NWP 44 non-coal mining activities, which requires Pre-construction Notification (PCN) for all activities;
- NWP 12 utility line activities, which requires a PCN for an area where a Section 10 permit is required (utility installation in navigable waters), when a utility line in waters of the U.S. exceeds 500 feet, when a utility line is placed within a jurisdictional area and it runs parallel to a stream bed that is within that jurisdictional area, when more than 0.1 acre will be impacted, or when permanent access roads are constructed in waters of the U.S. with impervious materials; and
- NWP 14 linear transportation projects, which requires a PCN when more than 0.1 acre will be impacted or if there is a discharge in a special aquatic site, including wetlands.

NWP 44, NWP 12, and NWP 14 have an acreage impact limit of one-half acre for waters of the United States (e.g. jurisdictional). Potential impacts to Other Waters of the United States (OWUS) are not considered under the acreage limit. Wetlands will not be impacted by the construction of the Satellite facilities. Wetlands or surface water channels may be impacted by the construction of wellfields. Approximately 6.6 acres of wetlands or water bodies fall within the boundaries of the ore bodies. Of those, approximately 1.8 acres are potentially jurisdictional. The actual acreage of impacted wetlands and water bodies will be determined when the final design for the wellfields is complete.

Wetlands and water bodies within the 19,888 acre site were delineated June 2 through the 12 and August 5 through 10, 2008. The majority of the wetlands and water bodies identified were small, disconnected depressions within ephemeral drainages. Wetlands identified included groundwater slope wetlands, depressions within ephemeral and intermittent drainages, diked ephemeral drainages, or isolated depressions. All of the wetlands within the site are classified as Palustrine Emergent according to the Cowardin classification system (Cowardin, et al, 1979). Many of the wetlands also have an open water component and are therefore also classified as Palustrine Unconsolidated Bottom. As a general rule, one data collection point was used for a series of small disconnected wetlands within the same drainage. Approximately 59.6 acres of wetland were identified (233 individual wetlands).

Water bodies identified were either depressions within ephemeral drainages, behind dikes in ephemeral drainages, or isolated depressions. None of the water bodies contained flowing water. Approximately 29.3 acres of water bodies were identified (195 individual water bodies).

The investigation identified approximately 59.64 acres of wetlands which represents emergent depressional wetlands associated with surface water drainage features, or emergent isolated depressions. Approximately 0.3 percent of the 19,888-acre proposed project area meets the wetland criteria. The investigation identified approximately 29.3 acres of water bodies within the 19,888 acre site which is approximately 0.15 percent of the site.

Based upon published guidance, those wetlands and water bodies within intermittent waterways are likely jurisdictional and those wetlands and water bodies within ephemeral drainages are likely non-jurisdictional. Isolated features are also likely non-jurisdictional. Those features which are likely jurisdictional include 43 wetlands and four water bodies which represent 29.046 acres of the proposed project area.

Description of the three major drainages (Little Sand Creek, Running Dutchman Ditch, Sage Creek) is provided in Section 2.8.5.2.4.

7.2.6.2 Potential Surface Water Impacts from Sedimentation

Normal construction activities within the wellfields, Satellite facility locations and along the pipeline alignments and roads have the potential to increase the sediment yield of the disturbed areas. However, the relative size of these disturbances is small when compared to the size of the overall areas and to the size of the watersheds, and also have a short-term impact. Since wellfield decommissioning and reclamation activities will be on-going throughout the life of the project, the area to be reclaimed at the conclusion of operations will be reduced, although a slight increase in sediment yields and total runoff can still be expected. Since all natural flow within the project boundaries is ephemeral with no intermittent or perennial streams, potential impacts to surface water from construction, operations, and decommissioning activities are also limited to uncommon precipitation or runoff events.

The physical presence of the surface facilities including wellfields and associated structures, access roads, Satellite facilities, pipelines, facilities and other structures associated with ISR mining and processing of uranium are not expected to significantly change peak surface water flows because of the topography of the drainages at the site, the low regional precipitation, the absorptive capacity of the soils, and the small area of disturbance relative to the large drainage within and adjacent to the proposed project. In areas where these structures may affect surface water drainage patterns, diversion ditches

and culverts will be used to prevent excessive erosion and control runoff. In areas where runoff is concentrated, energy dissipaters are used to slow the flow of runoff to minimize erosion and sediment loading in the runoff.

No drainages or bodies of water will be significantly modified or altered within the proposed project area during project construction or operations. The potential for erosion is present due to the construction of the wells near the drainage. However, disturbance is short-term and disturbed areas will be reseeded soon after the wellfields are constructed.

Construction and/or industrial stormwater National Pollutant Discharge Elimination System (NPDES) permits will be obtained in accordance with WDEQ - Water Quality Division regulations. Best management practices will be implemented to reduce impacts according to storm water management plans developed for those permits.

7.2.6.3 Potential Surface Water Impacts from Accidents

Surface water quality could potentially be impacted by accidents such as excessive rainwater or runoff in impacted soil areas or failure or an uncontrolled release of process liquids due to a wellfield leak. Section 7.5 presents a discussion of the measures to be used to prevent and control wellfield spills. Process buildings and chemical storage areas will be constructed with sumps or secondary containments, and a regular program of inspections and preventive maintenance will be implemented.

7.2.7 Potential Ecological Impacts of Operations

7.2.7.1 Vegetation

Wellfield and Satellite facilities will be constructed within four of the vegetation communities in the proposed project. Those vegetation communities are Big Sagebrush Shrubland, Lowland Grassland, Upland Grassland, and Upland Grassland Rough Breaks Complex. Potential direct impacts include the short-term loss of vegetation (modification of structure, species composition, and areal extent of cover types). Potential indirect impacts would include the short-term and long-term invasion, establishment, and expansion of non-native species, exposure of soils to accelerated erosion, shifts in species composition or changes in vegetative density, reduction of wildlife habitat, reduction in livestock forage and changes in visual aesthetics. The total surface area of the proposed project to be affected by the proposed operation is within the project area and is estimated to total 815 acres.

Construction activities, increased soil disturbance, and higher traffic volumes could stimulate the introduction and spread of undesirable and invasive, non-native species

within the proposed project area. Non-native species invasion and establishment has become an increasingly important result of previous and current disturbance in Wyoming. These species often out-compete desirable species, including special-status species, rendering an area less productive as a source of forage for livestock and wildlife. Additionally, sites dominated by invasive, non-native species often have a different visual character that may negatively contrast with the surrounding undisturbed vegetation. The Converse County Weed and Pest District Supervisor will be consulted when weed concerns arise to help determine the best management practices for the specific weed infestation.

There were no federally listed threatened or endangered species were observed in the project area found during sampling; therefore, no impacts are anticipated. The Converse County designated noxious weeds wavyleaf thistle (*Cirsium undulatum*) and cheatgrass (*Bromus tectorum*) were encountered in the area during recent sampling.

Mitigation of vegetation impact will consist of temporary and permanent surface revegetation of disturbed areas. Revegetation practices will be conducted in accordance with WDEQ-LQD regulations and the mine permit. Disturbed areas will be seeded to establish a vegetative cover to minimize wind and water erosion and the invasion of undesired plant species. A long-term temporary seed mix may be used in wellfield and other areas where the vegetation will be disturbed again prior to final decommissioning and final revegetation. This long-term seed mix typically consists of one or more of the native wheatgrasses (e.g., western wheatgrass, and thickspike wheatgrass). Permanent seeding is accomplished with a seed mix approved by the WDEQ-LQD and landowners on private lands. The permanent seed mix typically contains native wheatgrasses, fescues and clovers. Wellfield areas may be fenced as necessary to prevent livestock access, which will enhance the establishment of temporary vegetation.

7.2.7.2 Wildlife and Fisheries

ISR production differs from conventional surface mining by using less intrusive extraction methods that are more efficient and, thus, have less impact on the surrounding area. ISR operations use a series of injection and production wells that extract the uranium from the ore body without physically removing the ore or overburden from the ground. The production area consists of a series of wells within a systematic pattern with a single processing facility to remove the uranium from the lixiviant. ISR has a much smaller impact footprint than conventional surface mining because topsoil stripping and habitat destruction are restricted to relatively small areas needed for the processing facilities and the access roads. The total surface area of the proposed project to be affected by the proposed operation is within the license area and is estimated to total 815 acres. Construction of the three Satellite facilities and associated structures will encompass approximately 15 acres. The Satellite facilities are anticipated to consist of an

80- x 140-foot processing building, associated parking, and other infrastructure within an approximate 1.5 acre area enclosed with security fencing. In addition, two surge ponds (each approximately 1.2 acres) will be separately enclosed in a 3.5 acre area with security fencing. The road disturbance acreage is approximately 37 acres and is calculated assuming approximately seven miles of 25-foot-wide main road and approximately 18 miles of eight-foot-wide, field roads.

The proposed total wellfield area to be used for the injection and recovery of solution over the twelve-year mine life (not including construction and decommissioning) will be approximately 763 acres. As indicated, most of that habitat disturbance will consist of scattered, confined drill sites for wells that will not result in large expanses of habitat being dramatically transformed from its original character as in other surface mining operations. During the construction and operation phases of the project, open mud pits used for well drilling and maintenance activities could pose a hazard to wildlife. This potential impact will be mitigated by the use of temporary fencing around all open mud pits to protect wildlife from this hazard. Therefore, most indirect impacts would relate to the displacement of wildlife due to increased noise, traffic, or other disturbances associated with the development and operation of the Ludeman Project, as well as from small reductions in existing or potential cover and forage due to habitat alteration, fragmentation, or loss. Indirect impacts typically persist longer than direct impacts. However, the nature of ISR mining decreases the occurrence of large-scale habitat alterations and, thus, the need for reclamation efforts that can result in dramatic differences between pre-construction and post-construction vegetative communities.

ISR production could potentially have direct and indirect impacts on local wildlife populations. These potential impacts may be both short-term (lasting until successful reclamation is achieved) and long-term (persisting beyond successful completion of reclamation). However, long-term impacts are not expected to be substantial due to the relatively limited habitat disturbance associated with this recovery method. The potential direct impacts of ISR production on wildlife include injuries and mortalities caused by collisions with project-related traffic or habitat removal actions such as topsoil stripping, particularly for smaller species with limited mobility such as some rodents and reptiles and restrictions on wildlife movement due to construction of fences. The likelihood for the impacts resulting in injury or mortality is greatest during the construction phase due to increased levels of traffic and physical disturbance during that period. Traffic will persist during production, but should occur at a reduced, and possibly more predictable level. Speed limits will be enforced during all construction and maintenance operations to reduce potential impacts to wildlife throughout the year, but particularly during the breeding season.

Repeated surveys over multiple, consecutive years in the proposed project area have documented that two wildlife species of particular concern do not occur in the proposed project area: the bald eagle and the mountain plover. Suitable habitat for the two species

(trees, sagebrush, and sparse, low-growth vegetation, respectively) is extremely limited, further minimizing the potential for both direct and indirect impacts for those species, and others that require similar habitats. Other wildlife species of concern, such as ferruginous hawks (*Buteo regalis*), that do occur in the area may potentially experience indirect impacts from increased travel and noise in the area during project construction and operation. However, the combination of documented nesting, the presence of potential alternate nesting and foraging habitat in the immediate vicinity, and the mobility of this species reduces impacts to ferruginous hawks and other such species. Sage grouse occur in small numbers in the project area but there are no active or inactive leks present.

7.2.7.3 Medium-Sized and Small Mammals

A variety of small and medium-sized mammal species occur in the vicinity of the general analysis area, although not all have been observed on the proposed project area itself. These include predators and furbearers. Observed species include: the coyote (*Canis latrans*), swift fox (*Vulpes velox*), badger (*Taxidea taxus*), White-tailed Jackrabbit (*Lepus townsendii*), cottontails (*Sylvilagus* spp.), Thirteen-lined ground squirrel (*Tamias minimus*), Black-tailed prairie dog (*Cynomys ludovicianus*), and the Deer mouse (*Peromyscus maniculatus*).

Medium-sized mammals (such as lagomorphs, coyotes, and foxes) may be temporarily displaced to other habitats during the initial uranium mining activities. Direct losses of some small mammal species (e.g., voles, ground squirrels, mice) may be higher than for other wildlife due to their more limited mobility and likelihood that they would retreat into burrows when disturbed, and thus be impacted by topsoil scraping or staging activities. However, given the limited area expected to be disturbed by the proposed project, such impacts would not be expected to result in major changes or reductions in mammalian populations for small or medium-sized animals. The species known to be, or potentially, present in the project area have shown an ability to adapt to human disturbance in varying degrees, as evidenced by their presence in CBM developments and residential areas of similar, or greater, disturbance. Additionally, small mammal species in the area have a high reproductive potential and tend to re-occupy and adapt to altered and/or reclaimed areas quickly.

7.2.7.4 Big Game Mammals

Pronghorn (*Antilocapra americana*) and mule deer (*Odocoileus hemionus*) are the only two big game species that regularly occur in the general analysis area for the proposed project. No crucial big game habitat or migration corridors are recognized by the WGFD in this area. Crucial range is defined as any particular seasonal range or habitat component that has been documented as the determining factor in a population's ability to maintain and reproduce itself at a certain level.

Pronghorn are more abundant than mule deer in the proposed project area, but neither species is prevalent. Upland grasslands dominate the proposed project area and immediate perimeter. Although grassland habitats do provide adequate forage during much of the year, they are not considered as preferred by wintering pronghorn (Sundstrom et al. 1973). The home range for pronghorn can vary between 400 to 5,600 acres, depending on several factors including season, habitat quantity and quality, population characteristics, physical movement barriers, and local livestock occurrence. In northeast Wyoming, daily movement typically does not exceed six miles. Pronghorn may make seasonal migrations between summer and winter habitats, but migrations are often triggered by availability of specific plants and not local weather conditions (Fitzgerald et al. 1994).

The WGFD has classified the general analysis area as yearlong pronghorn range, which means that a population or a portion of a population of animals makes general use of this habitat on a year-round basis.

Mule deer use nearly all habitats, but prefer sagebrush-grassland, rough breaks, and riparian bottomland. Browse is an important component of the mule deer's diet throughout the year, comprising as much as 60 percent of total intake during autumn, while forbs and grasses typically make up the rest of their diet (Fitzgerald et al. 1994). Mule deer are not abundant in the general analysis area, with most individuals recorded in eroded draws and small tree windbreaks in that vicinity. In certain areas of the state, this species tends to be more migratory than white-tailed deer, traveling from higher elevations in the summer to winter ranges that provide more food and cover. However, monitoring indicates that mule deer are not very migratory in the vicinity of the proposed project. The WGFD has classified the majority of the general analysis area as yearlong mule deer range, with a portion of the proposed project area south of the highway classified as "out".

Under the proposed action, big game could be displaced from portions of the proposed project to adjacent areas, particularly during construction of the wellfield and facilities, when disturbance activities would be greatest. Disturbance levels would decrease during actual production and restoration operations and would consist primarily of vehicular traffic on improved and unimproved (two-track) roads throughout the project area. Pronghorn would be most affected, as they are more prevalent in the area. However, no areas classified as crucial pronghorn habitat occur on or within several miles of the proposed project area and this species is not as common in the general analysis area as elsewhere within the region due to the limited presence of sagebrush in the area. Mule deer would not be substantially impacted given their infrequent use of these lands, the paucity of winter forage and security cover, and the availability of suitable habitat in adjacent areas. The WGFD does not consider the general area to be within the "use range" of any other big game species. Sightings of those species in that vicinity are rare, if they occur at all.

7.2.7.5 Upland Game Birds

No known greater sage-grouse (*Centrocercus urophasianus*) or sharp-tailed grouse (*Tympanuchus phasianellus*) leks were documented within the proposed project survey area (proposed project area and one-mile perimeter, defined by the WGFD) prior to baseline surveys in 2008. Few sage-grouse and no sharp-tailed grouse were observed in the proposed project survey area.

The mourning dove (*Zenaida macroura*) was the only other upland game bird that was observed in or near the proposed project area during 2008. Mourning doves were most often recorded along the North Platte River as it passes through the extreme southern portion of the one-mile perimeter. Doves were also documented in tree windbreaks at occupied ranches or in individual trees located throughout the project area. This species is a relatively common breeder in Converse County, and is the most prevalent upland game bird in the general analysis area. Doves are often seen in the area during migration, with fewer observations during the nesting season.

Given the limited area expected to be disturbed by the proposed project, such impacts would not be expected to result in major changes of potential foraging and nesting habitat for mourning doves. Additionally, doves are not restricted to treed habitats, nor are they subject to any special mitigation measures for habitat loss.

Baseline monitoring studies have repeatedly demonstrated that sage-grouse do not inhabit the proposed project area. As described previously in Section 2.8, those surveys encompassed most of the proposed project area and its one-mile perimeter for much of that period. No sage-grouse leks were observed in that region during any survey year. WGFD records and USDA-FS records also failed to document any sage-grouse leks within the area that encompasses the general analysis area (i.e., proposed Ludeman Project boundary and a one-mile perimeter). Given the lack of sage-grouse observations in the area, and the minimal quantity and marginal quality of potential sage-grouse habitat, Uranium One does not plan to conduct operational monitoring for sage-grouse.

7.2.7.6 Other Birds

Eleven USFWS avian species of concern were recorded within the proposed project survey area during 2008. Six of those 11 species are categorized as Level I, which indicates a need for conservation action (i.e., having a monitoring and mitigation plan): the greater sage-grouse (*Centrocercus urophasianus*), ferruginous hawk *(Buteo regalis)*, burrowing owl (Athene cunicularia), bald eagle *(Haliaeetus leucocephalus)*, Swainson's hawk (*Buteo swainsoni*), and short-eared owl (*Asio flammeus*). The remaining five species are considered Level II, for which continued monitoring is recommended: the lark bunting (*Calamospiza melanocorys*), grasshopper sparrow (*Ammodramus*

savannarum), loggerhead shrike (*Lanius ludovicianus*), vesper sparrow (Pooecetes gramineus), and lark sparrow (Chondestes grammacus).

Direct impacts to these 11 avian species could include injury or mortality due to encounters with vehicles or heavy equipment during construction or maintenance operations. Indirect impacts could include habitat loss or fragmentation and increased noise and activity that may deter use of the area by some species. Surface disturbance would be relatively minimal and would be greatest during construction. Enforced speed limits during all phases of the proposed project would reduce impacts to wildlife throughout the year, particularly during the breeding season.

7.2.7.7 Raptors

Raptor species that are known to nest in the project area (proposed area and one-mile perimeter) are the ferruginous hawk, red-tailed hawk, and great horned owl. Seven additional raptor species were recorded in the proposed project survey area during 2008: the bald eagle, golden eagles, turkey vulture, Swainson's hawk, northern harrier, short-eared owl, and burrowing owl.

The final rule delisting the bald eagle was published in the Federal Register on July 9, 2007 (Federal Register: Vol. 72, No. 130, pg. 37345-37372 July 9, 2007). Delisting became effective 30 days after publication of this rule, on August 8, 2007. However, this species will continue to be protected under both the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. The bald eagle is considered a breeder in portions of Converse County, Wyoming (Cerovski et al. 2004). In the proposed project area, nesting and winter roosting habitat for this species is primarily limited to the cottonwood corridor in the southeastern portion of the one-mile perimeter along the North Platte River.

In accordance with WDEQ LQD requirements, a raptor nest survey is conducted in late April or early May each year to identify any new nests and assess whether known nests are being utilized. The survey covers all areas of planned activity for the life of mine (i.e., wellfields and Satellite facilities) and a one mile area around the activity. Status and production at known nests will be determined, if possible. This survey program is primarily intended to protect against unforeseen conditions such as the construction of a new nest in an area where operations may take place. Wildlife studies on the Ludeman Project will include annual raptor surveys.

ISR of uranium in the proposed project would not impact regional raptor populations, though individual birds or pairs may be affected. Production activity could cause raptors to abandon nests proximate to disturbance, particularly if mining encroaches on active nests during a given breeding season. Construction activities associated with the proposed

project that occur within or near active raptor territories would temporarily impact the availability of foraging habitat for nesting birds. However, equipment yards associated with production provide additional habitat for prey species such as cottontails and raptors have been documented voluntarily nesting quite near those areas. Other potential direct impacts to these species are limited to injury or mortality due to potential collisions with mine-related vehicular traffic. As at other surface mines throughout the region, including nearby uranium projects, nesting raptors in the proposed project area have likely been influenced primarily by natural factors such as prey abundance and availability of nesting substrates. Due to the paucity of woody vegetation and river cliffs, raptors that nest in trees or on high cliffs are not as abundant as those that either nest on the ground or are adaptable to nesting on facilities or other man-made structures (platform nests, etc.). During active production, new nesting habitat can be created through enhancement efforts (nest platforms, nest boxes, and tree plantings) to mitigate any negative impacts associated with the project. Additionally, mining related activities are limited to relatively small areas for limited periods of time. It is not anticipated that ISR related activities will adversely affect a raptor nest, or disturb a nesting raptor as there is a lack of nesting raptors on and near the plant and wellfield areas due to the lack of trees and other nesting sites.

Overhead power lines can present an electrocution hazard to raptors. In order to mitigate this hazard, all new power lines will be constructed using designs that meet or exceed current APLIC (2006) recommendations, thus minimizing any risks of electrocution on those structures. Those designs include, but are not limited to:

- a minimum of 60 inches between parallel phase lines (energized wires) achieved using 10-foot cross arms or by lowering the cross arm to increase spacing from the center wire
- the use of perch deterrents where 60-inch spacing cannot be achieved and between lightening arrestors or other hardware that might result in electrocution;
- covered/insulated jumper lines;
- covered ground wires;
- bushing covers on transformers;
- insulation on other energized hardware on transformers, cross arms, etc.; and
- other appropriate equipment, as needed to minimize impacts to perched raptors.

7.2.7.8 Fish and Macroinvertebrates

Potential habitat for reptiles, amphibians, and aquatic species is quite limited within the proposed project area and occurs primarily in the ephemeral Gilbert Lake, and as ephemeral or intermittent habitat associated with small, scattered stock ponds or drainages in the area. Under natural conditions, aquatic habitat on and near the proposed

project is limited by the ephemeral nature of surface waters in the general analysis area. The lack of deep-water habitat, and extensive and persistent water sources precludes the presence of fish, and limits the abundance and diversity of other aquatic species. The largest water body is the ephemeral Gilbert Lake, located at the extreme eastern extent of the project area. The lake held water throughout the 2008 baseline study period but not enough to sustain aquatic life such as fish. No quantitative surveys for fish were required or conducted specifically for the proposed project since all potential habitats are ephemeral in nature. .

7.2.7.9 Threatened and Endangered Species

No Threatened or Endangered vertebrate species have been documented in the proposed project survey area, and none were observed there during baseline wildlife surveys conducted in 2008. Likewise, no current (as of September 2008) candidate, petitioned, or proposed vertebrate species were recorded during recent or previous surveys.

7.2.7.9.1 Bald Eagle

The bald eagle was delisted from its Threatened status on June 28, 2007 in the lower 48 states. Its primary legal protection was transferred from the Endangered Species Act to the Bald and Golden Eagle Protection Act (BGEPA).

Bald eagles were observed within the one-mile perimeter of the Survey Area in 2008. No bald eagle nests or consistent winter roost sites were identified in the proposed project area. As bald eagle nests and winter roost sites are absent in the study area, potential hazards for this species would be limited to foraging individuals during winter.

Direct impacts to bald eagles would include the potential for injury or mortality to individual birds foraging in the project area due to collisions with mine-related equipment during construction or operation of the proposed project. The increased human presence and noise associated with construction activities, if conducted while eagles are wintering within the area, could displace individual eagles from using the area during that period. As bald eagles have not been documented in the proposed project area, impacts of the proposed action would be limited to occasional foraging individuals rather than a large segment of the population. If necessary, the majority of direct impacts could be mitigated if construction activities were conducted outside the winter and early spring months, or outside the daily roosting period, should eagles be present in the proposed project area during construction. Any bald eagles that might roost or nest in the area once the mine is operational would be doing so in spite of continuous and on-going human disturbance, indicating a tolerance for such activities.

Potential indirect impacts such as area avoidance could result from increased noise and human presence associated with mining related operations. Potential winter foraging habitat could be further fragmented by linear disturbances such as fences and new roads associated with the project. Given the size of the proposed project, those disturbances would occur within narrow corridors over relatively short distances.

ISR production at the proposed project may affect, but is not likely to adversely affect, bald eagles. As bald eagle nests and winter roost sites are absent in the study area, potential hazards for this species would be limited to foraging individuals during winter. Due to the lack of potential nesting or roosting sites and the lack of concentrated sources of prey, both the direct and indirect effects of the proposed action to bald eagles are expected to be minimal.

7.2.7.9.2 Reptiles, Amphibians, and Fish

Potential habitat for reptiles, amphibians, and aquatic species is quite limited within the proposed license area and occurs primarily in Gilbert Lake, or as ephemeral or intermittent habitat associated with small, scattered stock ponds or drainages in the area. The only amphibian that was encountered in the proposed project area, in the 2008 ICF Jones & Stokes survey, was the boreal chorus frog (*Pseudacris triseriata*). One bullsnake (*Pituophis melanoleucas*) was observed in the western portion of the proposed project area in early August. No fish were sampled or observed incidentally in the North Platte River during baseline studies for this project.

Activities associated with the proposed project are not expected to disturb existing surface water or alter the topography in the area. Furthermore, under natural conditions, such habitat is limited in the project area and few observations of aquatic species have been recorded there over time as the drainages within the proposed project area and two-mile buffer are ephemeral in nature except for the North Platte River.. Potential impacts to surface water flow and channels are expected to be minimal, as no significant alterations to these features would result from construction and operations. Additionally, any primary channels and surface water flow affected during mining would be restored during reclamation.

7.2.7.10 Waterfowl and Shorebirds

Avian species recorded in the proposed project area included several common waterfowl, wading bird, and shorebird species, such as the mallard (*Anas platyrhynchos*), gadwall (*A. strepera*), green-winged teal (*A.* crecca), American wigeon (*A. Americana*), great blue heron (*Ardea herodias*), killdeer (*Charadrius vociferous*), and Wilson's phalarope (*Phalaropus tricolor*). The majority of these wetland birds were observed at Gilbert Lake in the extreme eastern portion of the proposed project area. The western kingbird

(*Tyrannus verticalis*), Say's phoebe (*Sayornis saya*), common nighthawk (*Chordeiles minor*), and rock wren (*Salpinctes obsoletus*) were also seen within the proposed project area, as were other common species (Addendum 2.8-K). The nighthawk, eastern kingbird (*Tyrannus tyrannus*), and other species were also documented in the surrounding perimeter.

Under natural conditions, the proposed project area provides extremely limited and marginal habitat for waterfowl and shorebirds. As described for other aquatics-related species, above, natural aquatic habitats are mainly present during spring migration. Many of those water features are reduced to small, isolated pools or are completely dry during summer.

Construction and operation of the proposed project would have a negligible effect on migrating and breeding waterfowl and shorebirds. Little existing habitat is present in the area, so it does not currently support large groups or populations of these species. Ponding of water from fluid releases during operations will be immediately removed, minimizing any contact of released fluids with waterfowl or shorebirds. Any new treated water sources would enhance current habitat conditions for these species, though such effects may be ephemeral and temporary in nature. Habitat disturbance in drainages or other potential water sources would be reclaimed once productive operations have ceased. Replacement of any impacted jurisdictional wetlands would be required in accordance with Section 404 of the Clean Water Act.

7.2.8 Potential Noise Impacts of Operations

There is a small rural subdivision (Negley Subdivision) in the vicinity of and one residence in the proposed project. The proposed North Platte facility site is approximately 1.2 miles from the property boundary and Highway 93. The rest of the project area is primarily open rangeland. Other land uses include natural gas pipeline facilities, as well as pastureland located to the east, north and west of the proposed project area.

The proposed Leuenberger Satellite facility site is approximately one half mile from the property boundary of the Negley Subdivision and approximately one mile from the Leuenberger Ranch house. Assuming that the noise level produced by unshielded machinery at the facility site is 85dB at 50 feet, the sound pressure level attained at the property boundary will be below the level identified by the USEPA as suitable for outdoor areas where human activity takes place (approximately 55 dB[1]). A level of 85 dB is the OSHA threshold at which a hearing conservation program at the plant would be required. Experience at operating ISR facilities verifies that this assumption is conservative and that the average sound pressure levels during construction will be less than 85 dB. After appropriate engineered controls (i.e. the protective enclosure for the equipment) are installed, noise levels will not impact the residences, and are unlikely to

approach the levels attained by State Highway 95. Therefore, impact to noise or congestion above ambient background noise within the proposed project area or in the surrounding two-mile area is not anticipated. Additionally, given the maximum increase in population due to migrant workers is insignificant, noise and congestion impacts are not anticipated in Glenrock or other neighboring counties.

As a result of the remote location of the project and the low population density of the surrounding area, impact to noise or congestion within the project area or in the surrounding two-mile area are not anticipated. Additionally, given the maximum increase in population due to migrant workers is insignificant, noise and congestion impacts are not anticipated in Campbell or other neighboring counties.

7.2.9 Potential Cumulative Impacts

7.2.9.1 Potential Cumulative Impacts of Other Uranium Development Projects

The Powder River Basin has been historically developed for the recovery of uranium using ISR and conventional (underground and pit) mining. The only existing licensed uranium projects currently located in the Powder River Basin are the Smith Ranch/Highland Uranium Project (operated by Power Resources, Inc.) and the Willow Creek Project operated by Uranium One USA These ISR projects are located approximately ten miles north-northeast and 70 miles north-northwest of the proposed project, respectively. For the purposes of this discussion potential cumulative impacts will be addressed for the Smith/Highland Uranium Project and the proposed Ludeman Project due to the proximity of these facilities. Considering the distance between the existing projects and the proposed Ludeman Project, potential cumulative environmental impacts are not expected.

7.2.9.1.1 Potential Cumulative Land Use Impacts

As discussed in Section 2.2 of this Technical Report, rangeland is the primary land use within the proposed project and within the surrounding two-mile review area with the exception of the rural Negley subdivision and the Top of the World wind farm. There is one occupied housing unit in the proposed project area. To the north of the proposed project lies the Smith Ranch/Highland Uranium Project. Due to the minimal amount of surface disturbance (815 acres) potential land use impacts are anticipated to be small.

The potential cumulative impacts of the proposed project operations and the Smith Ranch/Highland Uranium Project include the restriction of wildlife and agricultural activities from the production areas and the removal of grazing lands through the construction of facilities, roads, and wellfields, however; due to the minimal surface

disturbance associated with ISR operations potential land use conflicts are expected to be small.

7.2.9.1.2 Potential Cumulative Transportation Impacts

State Highways 95 and 93 pass through the northern end of the proposed project. As discussed in Section 3.2 of the ER, primary access to the proposed project will be through the use of these roadways. Delivery of construction materials to the proposed project and the Smith Ranch/Highland Uranium Project along with disposal of waste, resin transport, and maintenance vehicles would not significantly increase the quantity of traffic.

It is anticipated that heavy equipment will be transported primarily to the site during off-peak traffic hours minimizing the potential transportation impacts.

7.2.9.1.3 Potential Cumulative Geology and Soils Impacts

Potential geological impacts from the proposed project are expected to be minimal, if any, as with the nearby Smith Ranch/Highland Uranium Project. As such, no potential cumulative impacts to geology are anticipated. However, disturbance is short-term and disturbed areas will be reseeded soon after the wellfields are constructed.

As discussed in Section 2.6 of this document, the three Satellite facility locations are underlain by soils with a slight potential for water erosion and a severe potential for wind erosion. As with any soil disturbance the potential exists for increased erosion hazards. Mitigation measures are provided in Section 5 of the ER to minimize this potential.

7.2.9.1.4 Potential Cumulative Water Resources Impacts

Potential impacts to surface water resources at the proposed project are anticipated to be minimal as no drainages or bodies of water will be significantly modified or altered within the proposed project area during project construction or operations. All streams within the proposed project two mile buffer area and the Smith Ranch/Highland Uranium Project are ephemeral with the exception of the North Platte River. As such, potential cumulative impacts to surface water resources will be minimal. Mitigation measures are discussed in detail in Section 5 of the ER.

Potential cumulative impacts to groundwater resources are expected to be minimal as due to the distance from the Smith/Highland Uranium project to the proposed project. The instrumentation and control system and excursion monitoring system proposed to be used at the proposed project are designed to quickly detect any leaks, spills, or potential excursions,

so any area of impact would be small. Thus, there is an extremely small likelihood of any groundwater impacts extending off-site to create cumulative impacts.

7.2.9.1.5 Potential Cumulative Ecological Resources Impacts

Potential cumulative impacts on wildlife habitat could potentially occur from the proposed project in conjunction with other ISR facilities in the region. Environmental stressors to include the proposed project and other existing ISR uranium facilities on wildlife habitat consist of roads, transmission lines, pipelines, increased traffic, and agricultural activities. While the proposed project and other projects requiring state and federal approvals would be located and built in a manner that would avoid and minimize potential impacts, there may still be residual impacts such as temporary and permanent removal of habitat and subsequent removal of wildlife. Neither the proposed project nor the Smith/Highland Uranium Project are located inside the core sage grouse areas and crucial big-game ranges.

7.2.9.1.6 Potential Cumulative Air Quality Impacts

Projected activities at the proposed project impacting dust emissions include ongoing wellfield construction activities, routine site traffic related to operations and maintenance, heavy truck traffic delivering chemicals and material and shipping product, and employee traffic to and from the site. Fugitive dust and exhaust from construction activities are potential causes of decreases in air quality related to wind farm installation. Construction emissions would occur during potential road and pad construction and transmission line installation. Cumulative air quality impacts would occur during construction, operation, restoration, and decommissioning of ISR facilities. The amount of air pollutant emissions during construction is controlled by watering disturbed soils, and by air pollutant emission limitations. Cumulative impacts to air quality as a result of the proposed project and the Smith/Highland Uranium Project are anticipated to be small due to the distance between the projects.

It is not anticipated that there will be any significant potential impacts regarding radiological particulate or gaseous emissions from the Satellite facilities operations. Radiological gaseous emissions anticipated during operation are described in Section 7.3.

7.2.9.1.7 Potential Cumulative Noise Impacts

As a result of the remote location of the proposed project and the Smith/Highland Uranium Project and the relatively low population density of the surrounding area, impact to noise or congestion above ambient background noise within the proposed project area or in the surrounding two-mile area are not anticipated. ISR facilities create

little noise during operation. Consequently, no adverse potential cumulative impacts are anticipated.

7.2.9.1.8 Potential Cumulative Cultural Resources Impacts

A Class III cultural resource inventory of the proposed project was conducted in 2008 by Ethnoscience, Inc. of Billings Montana. As concluded in the Class III Inventory Report, provided in Appendix B, the currently proposed project will not affect any known significant cultural resources and additional archaeological work is not considered necessary.

Construction of the proposed project is designed to avoid potential impacts to pre-historic and historic properties and to minimize disturbance to such by implementing a stop-work procedure. As a result of the minimal land disturbance of ISR operations and mitigation measures provided in Section 5 of the ER, the risk of potential cumulative impacts to cultural resources is small.

7.2.9.1.9 Potential Cumulative Visual Impacts

The visible surface structures proposed for the proposed project and the Smith/Highland Uranium Project include wellhead covers, header houses, electrical distribution lines, booster pump houses, and Satellite/CPP facilities. The proposed project will use existing and limited new roads to access the Satellite facilities and each header house. Each wellhead cover typically consists of a weatherproof structure placed over the well. These covers are approximately three feet high and two feet in diameter. Each header house is a small metal building.

As a result of blending structures with the landscape, siting facilities in locations to minimize public view, and the distance between the Smith/Highland Uranium Project and proposed project potential cumulative visual impacts will be small.

7.2.9.1.10 Potential Cumulative Socioeconomic Impacts

As mentioned in Section 4.10 of the ER, the construction and decommissioning phases of the proposed project will cause a moderate impact to the local economy, resulting from the purchases of goods and services directly related to construction activities and increased demand for housing and other services. As the Smith/Highland Uranium Project is currently operating and requires minimal additional resources to continue operating no cumulative impacts are anticipated except for increased tax revenue as a result of income for both projects.

7.2.9.1.11 Potential Cumulative Health Impacts

Potential impacts to health as a result of the proposed project are discussed in Section 7.4 below. With proper mitigation measures in place as discussed in Section 5 of the ER, there are no anticipated cumulative impacts for ISR

7.2.9.2 Potential Cumulative Impacts of Coal Bed Methane Development Projects

The PRB has been developed since the mid-1980's for the recovery of CBM. With advancements in technology, development and production of CBM has been increasing substantially since the mid-1990s. Development has been centered in all or parts of Campbell, Converse, Johnson, and Sheridan counties. The target coal zones are contained in the Fort Union formation.

Licensing and permitting applications have not been submitted to the regulatory agencies at the time of this application. As such, it is not possible for Uranium One to accurately predict the potential cumulative environmental impacts should CBM projects be developed.

7.2.9.3 Potential Cumulative Impacts of Wind Farm Projects

In recent years the PRB has seen growth in the wind energy. Within the vicinity of the proposed project area exists the Top of the World wind farm owned by Duke Energy and the PacificCorp wind farm. Several wind turbines from the The Top of the World wind farm are within the two mile buffer west of the project boundary. The wind farm operated by PacificCorp is outside of the two mile buffer and is located approximately 6.5 miles northwest of the property boundary. The two wind farms combined have a total of 268 windmills stretched over 16 miles long and 3.5 miles wide..

Potential cumulative impacts include land use impacts by restricting access to portions of the area, geology and soils through pad and access road construction, ecological impacts on wildlife habitat through environmental stressors such as access roads and pad construction, air quality degradation through dust emissions during construction and operations, noise by increased traffic and construction, cultural resources disturbance during construction, visual impacts from dominant features such as the 400 feet high wind turbines found 1.5 miles west of the proposed project, socioeconomic implications include potential increased employment and increased tax revenue.

7.2.9.3.1 Potential Cumulative Land Use Impacts

As discussed in Section 2.2 of this Technical Report, rangeland is the primary land use within the proposed project and within the surrounding two-mile review area with the exception of the rural Negley subdivision and the Top of the World wind farm operated by Duke Energy. There is one occupied housing unit in the proposed project area. The total surface area of the proposed project to be affected by the proposed operation is estimated to total 815 acres.

The potential cumulative impacts of the proposed project operations and the wind farm include the restriction of wildlife and agricultural activities from the production areas and the removal of grazing lands through the construction of facilities, roads, and windmill pads.

7.2.9.3.2 Potential Cumulative Transportation Impacts

State Highways 95 and 93 pass through the northern end of the proposed project. Primary access to the proposed project will be through the use of these roadways. Delivery of construction materials to the proposed project and the Top of the World wind farm along with disposal of waste, resin transport, and wind farm maintenance vehicles would not significantly increase the quantity of traffic.

It is anticipated that heavy equipment will be transported primarily to the site during off-peak traffic hours minimizing the potential transportation impacts.

7.2.9.3.3 Potential Cumulative Geology and Soils Impacts

Potential geological impacts from the proposed project are expected to be minimal, if any, as with the nearby wind farm. As such, no potential cumulative impacts to geology are anticipated. However, disturbance is short-term and disturbed areas will be reseeded soon after the wellfields are constructed.

As discussed in Section 2.6 of this document, the three proposed Satellite facility locations are underlain by soils with a slight potential for water erosion and a severe potential for wind erosion. As with any soil disturbance the potential exists for increased erosion hazards. Mitigation measures are provided in Section 5 of the ER to minimize this potential.

7.2.9.3.4 Potential Cumulative Water Resources Impacts

Potential impacts to surface water resources at the proposed project are anticipated to be minimal as no drainages or bodies of water will be significantly modified or altered within the proposed project area during project construction or operations. All streams within the proposed project two mile buffer area and the Top of the World wind farm are ephemeral with the exception of the North Platte River. As such, potential cumulative impacts to surface water resources will be minimal. Mitigation measures are discussed in detail in Section 5 of the ER.

Potential cumulative impacts to groundwater resources are expected to be minimal as wind farms have no impact to groundwater.

7.2.9.3.5 Potential Cumulative Ecological Resources Impacts

Potential cumulative impacts on wildlife habitat could potentially occur from the proposed project in conjunction with other action in the proposed project buffer area. Environmental stressors to include the proposed project on wildlife habitat consist of roads, transmission lines, pipelines, windfarms, and agricultural activities. While the proposed project and other projects requiring state and federal approvals would be located and built in a manner that would avoid and minimize potential impacts, there may still be residual impacts such as temporary and permanent removal of habitat and subsequent removal of wildlife. Neither the proposed project nor the Top of the World wind farm are inside the core sage grouse areas and crucial big-game ranges.

7.2.9.3.6 Potential Cumulative Air Quality Impacts

Projected activities at the proposed project impacting dust emissions include ongoing wellfield construction activities, routine site traffic related to operations and maintenance, heavy truck traffic delivering chemicals and material and shipping product, and employee traffic to and from the site. Fugitive dust and exhaust from construction activities are potential causes of decreases in air quality related to wind farm installation. Construction emissions would occur during potential road and pad construction and transmission line installation. Maximum air pollutant emissions from each windmill would be temporary (i.e., occurring during a short construction period) and would occur in isolation as with the development and operation of the proposed project. Air quality impacts would occur during production for maintenance on the windmills and associated structures (i.e., transmission lines and transformers). The amount of air pollutant emissions during construction is controlled by watering disturbed soils, and by air pollutant emission limitations.

7.2.9.3.7 Potential Cumulative Noise Impacts

As a result of the remote location of the proposed project and the Top of the World wind farm and the relatively low population density of the surrounding area, impact to noise or congestion above ambient background noise within the proposed project area or in the surrounding two-mile area are not anticipated. Wind turbines create little noise usually masked by the wind itself. Consequently, mo adverse potential cumulative impacts are anticipated.

7.2.9.3.8 Potential Cumulative Cultural Resources Impacts

A Class III cultural resource inventory of the proposed project was conducted in 2008 by Ethnoscience, Inc. of Billings Montana. As concluded in the Class III Inventory Report, provided in Appendix B, the currently proposed project will not affect any known significant cultural resources and additional archaeological work is not considered necessary.

Construction of the proposed project is designed to avoid potential impacts to pre-historic and historic properties and to minimize disturbance to such by implementing a stop-work procedure.

7.2.9.3.9 Potential Cumulative Visual Impacts

The visible surface structures proposed for the proposed project include wellhead covers, header houses, electrical distribution lines, booster pump houses, and three Satellite facilities. The project will use existing and limited new roads to access the Satellite facilities and each header house. Each wellhead cover typically consists of a weatherproof structure placed over the well. These covers are approximately three feet high and two feet in diameter. Each header house is a small metal building.

The dominant feature of the landscape of the wind farm 1.5 miles to the west of the proposed project are the 268 wind turbines. The wind turbines are approximately 400 feet in height and are spaced approximately 750 feet apart in multiple rows over 15 miles. These structures are visible at night due to the lighting requirements by the Federal Aviation Administration (FAA) on all structures over 200 feet high. These requirements can range from white strobes to red flashing lights.

7.2.9.3.10 Potential Cumulative Socioeconomic Impacts

As mentioned in Section 4.10 of the ER, the construction and decommissioning phases of the proposed project will cause a moderate impact to the local economy, resulting from

the purchases of goods and services directly related to construction activities and increased demand for housing and other services. As the wind farm is currently operating and requires little additional resources to continue operating no cumulative impacts are anticipated except for increased tax revenue as a result of income for both projects.

7.2.9.3.11 Potential Cumulative Health Impacts

Potential impacts to health as a result of the proposed project are discussed in Section 7.4 below. Wind farms only have a slight potential impact to health generally only occurring in the immediate vicinity of the individual windmill. As there are no overlapping health effects between the two projects, potential cumulative impacts are not anticipated to occur.

7.3 RADIOLOGICAL EFFECTS

7.3.1 Potential Public Radiological Effects

Uranium One is proposing to develop a uranium ISR facility (facility) with a production and restoration flow of approximately 9,000 and 3,000 gallons per minute (gpm) respectively (ie, 3,000 and 1,000 per Satellite.) An assessment of the radiological effects from the facility must consider the types of emissions, the potential pathways present, and an evaluation of potential consequences of radiological emissions.

The facility will use fixed bed pressurized down flow ion exchange columns to separate uranium from the pregnant production fluid and to treat restoration solutions. The uranium contained in the loaded resin from the ion exchange columns will be precipitated and subsequently vacuum dried off site.

In addition to ion exchange treatment, the groundwater restoration process will also use reverse osmosis to remove the dissolved solids. Liquid waste disposal will be via a direct deep well injection. Each Satellite facility will be accompanied by surge ponds to be utilized during maintenance or when disposal wells are temporarily inoperable.

The proposed project will consist of three Satellite facilities with processing flow rates of 3,000 gpm each and 1,000 gpm each restoration capacity. Each Satellite facility will generate uranium loaded ion exchange resin. An average of 1 resin transfer per day at each Satellite facility is anticipated.

Since the drying and packaging operation will be conducted off-site, the only expected routine emission at the facility will be radon-222 gas. Radon-222, a decay product of radium-226, is dissolved in the lixiviant as it travels through the ore to a production well

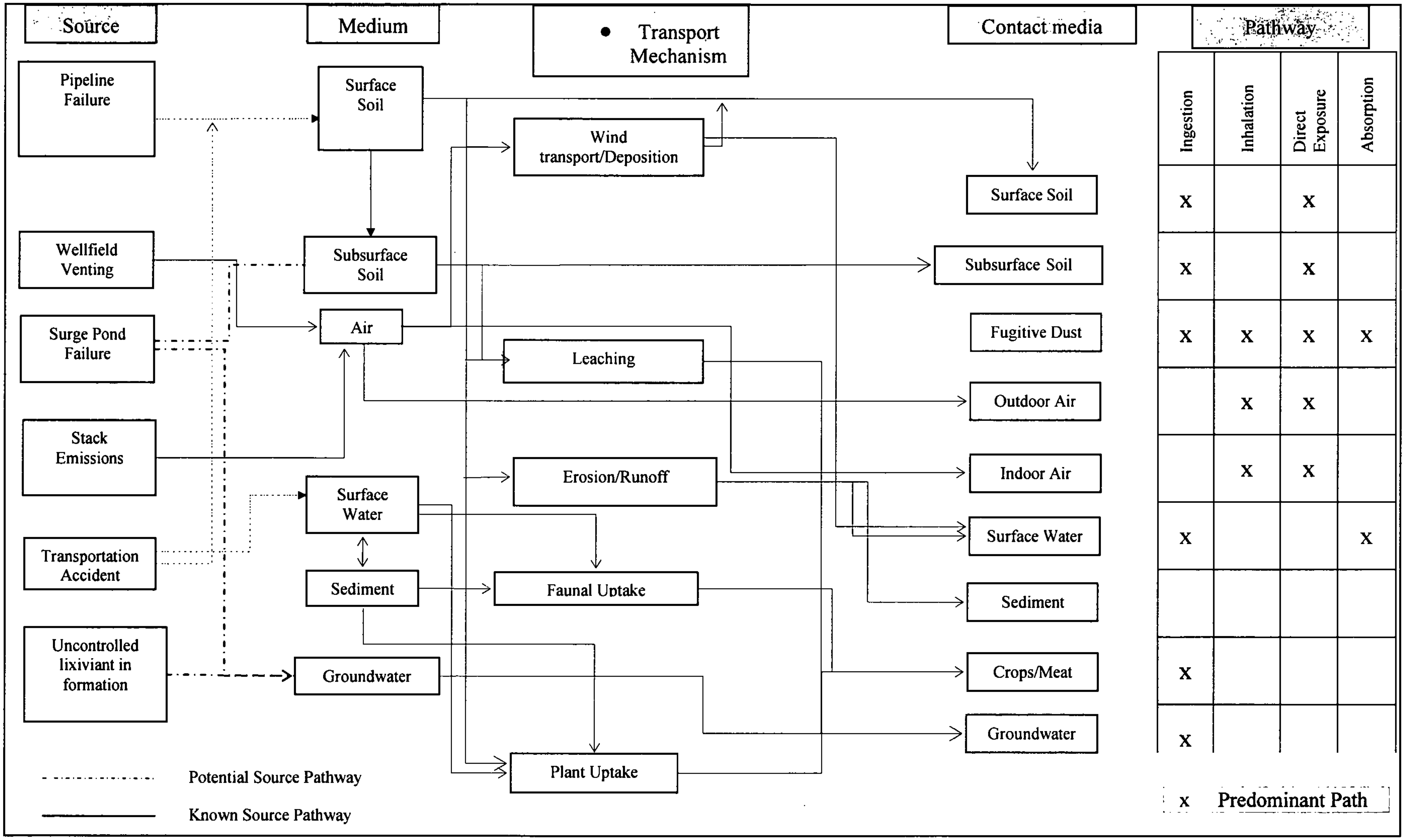
where it is brought to the surface. The concentration of radon-222 in the production solution and estimated releases are calculated using the methods found in USNRC Regulatory Guide 3.59, "Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations" (NRC, 1987). The details of and assumptions used in these calculations are found in Section 7.3.3.

MILDOS-AREA is used to model radiological impacts on human and environmental receptors (e.g. air and soil) using site-specific radon-222 release estimates, meteorological and population data, and other parameters. The estimated radiological impacts resulting from routine site activities will be compared to applicable public dose limits as well as naturally occurring background levels.

7.3.1.1 Exposure Pathways

Figure 7.3-1 presents exposure pathways from all potential sources at the facility. The predominant pathways for planned and unplanned releases are identified. As mentioned earlier, atmospheric radon-222 is expected to be the predominant pathway for impacts on human and environmental media. Impacts of radon-222 releases can be expected in all quadrants surrounding the facility, the magnitude of which is driven predominantly by wind direction and atmospheric stability. As a noble gas, radon-222 itself has very little radiological impact on human health or the environment. Radon-222 has a relatively short half-life (3.2 days) and its decay products are short lived, alpha emitting, nongaseous radionuclides. These decay products have the potential for radiological impacts to human health and the environment. As Figure 7.3-1 shows, all exposure pathways, with the possible exception of absorption, can be important depending on the environmental media impacted. All of the pathways related to air emissions of radon-222 are evaluated by MILDOS-AREA. MILDOS-AREA modeling output is in contained in Appendix C.

Figure 7-2: Human Exposure Pathways for Known and Potential Sources



7.3.1.2 Exposures from Water Pathways

The mining solutions in the Production Zone will be controlled and adequately monitored to ensure that migration does not occur. The overlying aquifers will also be monitored.

The primary method of waste disposal at the facility will be by deep well injection. The deep injection wells will be completed at a depth sufficiently deep enough to geologically isolate waste from underground sources of drinking water. The wells will be constructed under a permit from the Wyoming Department of Environment Quality (WDEQ) and all requirements of the Underground Injection Control (UIC) program will be met.

No routine liquid environmental discharges, other than waste disposal via deep well injection, are planned and as such, no definable water related pathways for routine operations exist.

7.3.1.3 Exposures from Air Pathways

The only source of radionuclide emissions is radon-222 released into the atmosphere through a vent system in the Satellite facilities or from the wellfields. As shown in Figure 7.3-1, atmospheric releases of radon-222 can result in radiation exposure via three pathways; inhalation, ingestion, and external exposure. The Total Effective Dose Equivalent (TEDE) to nearby residents in the region around the facility was estimated using MILDOS-AREA.

7.3.1.3.1 Source Term Estimates

The source terms used to estimate radon-222 releases from the facility include three well fields in production, three restoration well fields, new well field development, and three Satellite facilities. The wellfields were chosen based on their proximity to the nearest process plant and site boundary. The parameters used to characterize and estimate releases are provided in Table 7-4.

Table 7-2: Parameters used to estimate and characterized source terms at the proposed project recovery facility

Parameter	Value	Unit	Source
Average ore grade	0.1	%	Application
Ore radium-226 concentration	282	pCi g-1	Reg. Guide 3.59
Average lixiviant flow per facility	1.14E+04	L m-1	Application
Average restoration flow per facility	3.79E+03	L m-1	Application
Operating days per year	365	days	
Ore formation thickness	3	meters	Application
Ore formation porosity	0.25	NA	Application
Ore formation rock density	1.83	g cm-3	Application
Average residence time for lixiviant	7	days	Application
Average residence time for restoration solutions	35	days	Application
Average mass of ore material in mud pit	5.44E+05	g	Estimate based on planned activities
Number of mud pits generated per year (entire site)	600	NA	Estimate based on planned activities
Storage time in mud pits	30	days	Estimate based on planned activities
Radon-222 emanating power	0.25	NA	NUREG 1569
Resin porosity	0.3	NA	NUREG 1569
Volume of ion exchange resin	1.42E+04	L	Estimate based on planned activities
Number of resin transfers per day (at each facility)	1	NA	Estimate based on planned activities

Production Releases

The current plans are to have up to three production areas (one per Satellite facility) operating concurrently. The potential radon-222 releases from the production well fields were estimated using methods described in U.S. Nuclear Regulatory Commission (USNRC) Regulatory Guide (RG) 3.59, *Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations* as follows (NRC, 1987):

Radon released (equilibrium condition) to production fluid from leaching is calculated using Equation 1:

$$G = R\rho E \frac{(1-p)}{p} x10^{-6} \qquad \text{(Equation 1)}$$

Where:

G	=	radon released (Ci/m^3)
R	=	radium content of ore (pCi/g)
E	=	radon-222 emanating power
ρ	=	rock density ($g\ cm^{-3}$)
p	=	formation porosity

The yearly radon released to the production fluid is calculated using Equation 2:

$$Y = 1.44GMD(1 - e^{-\lambda t}) \qquad \text{(Equation 2)}$$

Where:

Y	=	yearly radon released to production fluid ($Ci\ yr^{-1}$)
G	=	radon released at equilibrium ($Ci\ m^{-3}$)
M	=	lixiviant flow rate ($L\ min^{-1}$)
D	=	production days per year (d)
λ	=	radon-222 decay constant ($0.181\ d^{-1}$)
t	=	lixiviant residence time
1.44	=	unit conversion factor

Using Equations 1 and 2 and the parameters in Table 7-4, the yearly radon released to production fluid is 1655 $Ci\ yr^{-1}$. USNRC RG 3.56 assumes all the radon-222 that is released to the production fluid is ultimately released to the atmosphere which in the case of ion exchange columns operating at atmospheric pressure in an open system is an appropriate conservative assumption (NRC, 1987). In cases where pressurized downflow ion exchange columns are used, and wellfields are operated under pressure, the majority of radon released to the production fluid stays in solution and is not released. The radon which is released is from occasional well field venting for sampling events, small unavoidable leaks in well field and ion exchange equipment, and maintenance of well field and ion change equipment. For this reason, estimated annual releases of 10% of the radon-222 in the production fluid would occur in the well fields and an additional 10% in the ion exchange circuit was assumed. Given this assumption, the annual radon-222 released from production in a mining unit and at the associated Satellite facility is 166 and 149 $Ci\ yr^{-1}$ respectively.

Restoration Release

Radon-222 releases resulting from wellfield restoration activities were estimated in the same manner as the production activities above (i.e. using Equation 2) but modified for the lower restoration flow rate and the longer restoration fluid residence time, both of which are listed in Table 7-5. The assumption of a 10% release at the production unit and associated Satellite facility results in releases of 76.9 and 69.2 $Ci\ yr^{-1}$ respectively.

New Wellfield Releases

Radon-222 releases resulting from new wellfield development activities were estimated using methods described in NUREG-1569, *Standard Review Plan for In Situ Leach Uranium Extraction License Applications* as follows (NRC, 2003):

$$Rn_{nw} = EL[Ra]TmNx10^{-12} \qquad \text{(Equation 3)}$$

Where:

Rn_{nw} = Radon-222 release rate from new well field (Ci yr^{-1})
E = emanating power
[Ra] = concentration of radium-226 in ore (pCi g^{-1})
L = decay constant of radon-222
T = storage time in mud pit (d)
m = average mass of ore material in the pit (g)
N = number of mud pits generated per year
10^{-12} = unit conversion factor (Ci pCi^{-1})

Since development of new wellfields are planned to occur throughout the site, the number of mud pits generated per year for the entire site were assumed to be equally distributed among the three facilities. Therefore, the number of mud pits generated per year at each facility was assumed to be 200. Using Equation 3 and the parameters in Table 7-4, the yearly radon released from new well field development for each facility is 0.041 Ci yr^{-1}. For purposes of the MILDOS-AREA model simulations, the new wellfield release was assumed to occur at each production unit.

Resin Transfer Releases

Radon-222 releases resulting from resin transfers at the Satellite facilities were estimated using methods described in NUREG-1569, *Standard Review Plan for In Situ Leach Uranium Extraction License Applications* as follows (NRC, 2003):

$$Rn_x = 3.65x10^{-10} F_i C_{Rn} \qquad \text{(Equation 4)}$$

Where:

Rn_x = Radon release rate from resin transfers (Ci yr^{-1})
F_i = water discharge rate from resin unloading (L d^{-1})
C_{Rn} = Steady state radon-222 concentration in process water (pCi L^{-1})
$3.65x10^{-10}$ = unit conversion factor (Ci pCi^{-1})(d yr^{-1})

The steady state radon-222 concentration in process water (C_{Rn}) can be estimated from the following expression:

$$C_{Rn} = \frac{Y * 1.9E6}{M} \qquad \text{(Equation 5)}$$

Where:

C_{Rn} = Steady state radon-222 concentration in process water (pCi L^{-1})
Y = yearly radon released to production fluid (Ci yr^{-1})
M = lixiviant flow rate (L min^{-1})
1.9E6 = unit conversion factor (pCi Ci^{-1})(yr min^{1})

The water discharge rate from resin unloading (Fi) can be estimated from the following expression:

$$F_i = N_i * V_i * P_i \qquad \text{(Equation 6)}$$

Where:

F_i = water discharge rate from resin unloading (L d^{-1})
N_i = Number of resin transfers per day
V_i = volume of resin in transfer (L)
P_i = porosity of resin

Using Equations 4-6 and the parameters in Table 7-4, the yearly radon released from resin transfers from Satellite facilities development is 0.430 Ci yr^{-1}. For purposes of the MILDOS-AREA model simulations, the resin transfer release was assumed to occur at each Satellite facility.

- Radon-222 Release Summary

A summary of estimated radon-222 releases from the facility is presented in Table 7-5. The source coordinates in Table 7-5 are relative to the approximate center of the license/permit boundary.

Table 7-3: Estimated Radon-222 Releases (Ci yr^{-1}) from the proposed Ludeman Project

Location	X (km)	Y (km)	Production	Restoration	Drilling	Resin Transfer	Total
Leuenberger Satellite	-6.86	-1.65	149	69.2	-	0.43	218.6
North Platte Satellite	0	0	149	69.2	-	0.43	218.6
Peterson Satellite	1.79	-5.51	149	69.2	-	0.43	218.6
Wellfield 1	-7.36	-1.41	166	76.9	0.04	-	242.9
Wellfield 2	-6.63	-2.11	146	76.9	0.04	-	242.9
Wellfield 3	-8.02	-1.14	146	76.9	0.04	-	242.9
Wellfield 4	0.02	-1.44	146	76.9	0.04	-	242.9
Wellfield 5	-2.47	-3.56	146	76.9	0.04	-	242.9
Wellfield 6	-0.09	-5.27	146	76.9	0.04	-	242.9
Wellfield 7	2.53	-6.77	146	76.9	0.04	-	242.9

7.3.1.3.2 Receptors

Two types of receptors were used in the MILDOS-AREA simulation. First, arbitrary receptors were identified based on a 0.5 km grid system across the site. The grid system was established using a random starting point. A total of 1189 arbitrary receptors were modeled to develop iso-dose curves within the permit boundary using the kriging method described in ArcMap GIS software. The arbitrary receptor are intended to represent worse case dose potentials for members of the public within the permit boundary. This conservative estimate would account for the rancher or hunter scenario. Second, potential receptor locations were identified and modeled. Data regarding the arbitraty receptors is shown in Appendix E of the Technical report, Appendix A (Table A.1). Potential resident receptors used in the MILDOS-AREA model are presented in Table 7-6 and are anticipated to be the highest public dose recipients. The receptor coordinates in Table 7-6 are relative to the North Platte satellite processing area. Annual dose estimates for residential receptors are based on 24 hours per day for one year.

7.3.1.3.3 Miscellaneous Parameters

The metrological data used in the MILDOS-AREA model is from the Joint Frequency Distribution data presented in Section 2.5 of this application.

The population distribution used in the MILDOS-AREA model to estimate population doses is from the demographic information presented in Section 2.3 of this application.

7.3.1.3.4 Total Effective Dose Equivalent (TEDE) to Individual Receptors

In order to show compliance with the annual dose limit found in 10 CFR 20.1301, Uranium One has demonstrated by calculation that the TEDE to the individual most likely to receive the highest dose from the facility is less than 100 mrem per year. The results of the MILDOS-AREA simulation for each receptor are presented in Table 7-6.

An evaluation of the TEDE follows:

1) The maximum TEDE of 1.56 mrem/yr, located at nearest resident (Resident 3) within the property boundary, is 1.6 percent of the public dose limit of 100 mrem as shown in Table 7-4. Resident 3 TEDE is from the projected 3rd year of operations;
2) The effect of the proposed Ludeman operation on any potential resident is less than 2% of the public dose limit;
3) Since radon-222 and its products are the only radionuclides emitted, public dose requirements in 40 CFR part 190 and the 10 mrem/y constraint rule in 10 CFR part 20.1101 do not apply; and
4) Even if 100% of the radon-222 contained in restoration and production fluids were released to the atmosphere (i.e. 100% released instead of 10%), the impacts to potential residents surrounding the facility would be less than the 100 mrem public dose limit;

Table 7-4: Ludeman Resident Receptor Numbers, Names, Locations and TEDE

Receptor	X (km)	Y (km)	TEDE ($mrem\ yr^{-1}$)
Resident 1	-5.17	-2.17	0.70
Resident 2	3.5	-11.5	0.27
Resident 3	5.3	-9.8	1.56
Resident 4	7.9	-9.2	0.20
Resident 5	8.5	-9.3	0.21
Resident 6	8.3	-10.0	0.21

7.3.1.3.5 Population Dose

The annual population dose commitment to the population in the region within 80 km of the facility is also predicted by the MILDOS-AREA code. The results are contained in Table 7-6 where TEDE is expressed in terms of person-rems. For comparison, the dose to the population within 80 km of the facility due to background radiation has been included

in the table. Background radiation doses are based on a North American population of 346 million and an average TEDE of 360 mrem.

The atmospheric release of radon also results in a dose to the population on the North American continent. This continental dose is calculated by comparison with a previous calculation based on a 1 kilocurie release near Casper, Wyoming, during the year 1978. The results of these calculations are included in Table 7-7 and also combined with dose to the region within 80 km (50 mi) of the facility to arrive at the total radiological effects of one year of operation at the proposed project.

The maximum radiological effect from the operations at the facility would be to increase the TEDE of continental population is very low and not measurable.

Table 7-5: Total effective dose equivalent (TEDE) to the population from one year of operation at the proposed project.

Criteria	TEDE (person rem/yr)
Dose received by population within 80 km of the facility	0.31
Dose received by population beyond 80 km of the facility	11.1
Total Continental Dose	11.4
Background North American Dose	1.0E+08
Fractional increase to background dose	1.1E-07

7.3.1.3.6 Exposure to Flora and Fauna

To estimate the potential radiological impacts to flora and fauna, the primary pathway for exposure should be identified. Since the only planned emissions from the facility is radon-222 to the atmosphere, the dominant pathway for exposure to flora and fauna is deposition of radon-222 decay products on surface water, surface soils, and vegetation. MILDOS-AREA estimates surface deposition rate as a function of distance from the source for the radon-222 decay products and calculates surface concentrations. Table 7-8 presents the highest surface soil concentrations of radon-222 decay products predicted by MILDOS-AREA over a 100 year period. Soil concentrations were calculated based on a conservative assumption of 1.5 g cm^{-3} bulk soil density.

Table 7-6: Highest surface concentrations of radon-222 decay products resulting from operations at the proposed project.

Radionuclide	Distance from site (km)	Direction	Surface Concentration (pCi/m^2)	Soil Concentration in upper 0.5 cm (pCi/g)
Polonium-218	1.5	S	33.7	0.004
Lead-214	1.5	S	33.7	0.004
Bismuth-214	1.5	S	33.7	0.004
Lead-210	65	E	14.1	0.002

Lead-210 represents the radionuclide with the highest concentration (2.0E-3 pCi/g) which is at least an order of magnitude below most analytical laboratories detection limits. Recent site specific surface soil (0-5 cm) data taken from nearby Moore Ranch show that concentrations of lead-210 in the geographical area have a mean of 0.5 pCi g^{-1} and a standard deviation of 0.4 pCi g^{-1} (EMC, 2007). The increase in soil radioactivity at the proposed project from operations is insignificant compared to site specific background concentrations.

It is likely that soil re-suspension from background soils would be the predominant source of lead-210 concentration in vegetation surrounding the site since lead-210 concentrations in vegetation would be similar to that of soil.

From this evaluation, the impact of operations at the proposed Ludeman Uranium In-Situ Recovery Facility would be minimal and indistinguishable from current conditions.

7.3.2 Occupational Radiological Impacts

The potential occupational doses for the proposed facility can be best estimated by comparison with doses actually reported for similar operating facilities. The Willow Creek Satellite is very similar to the planned design of the proposed Satellite facilities. Both plants employ the following elements to control worker exposure to ionizing radiation:

- The use of downflow pressurized ion exchange columns to limit the release of radon gas from the lixiviant; and
- The use of building ventilation systems to minimize airborne concentrations of radioactive materials during operations.

The Willow Creek site is subject to similar environmental conditions and involves similar industrial circumstances to the proposed Ludeman Satellite facilities. Occupational dose data was provided in the License Renewal Application for SUA-1341. The external dose data for Willow Creek and the maximum internal radon dose data were used to prepare

the following estimate of the maximum dose to workers at Ludeman in the following table. Note that the years 1995 to mid-2000 represent exposure data during plant operations. The data for the remainder of 2000 through 2005 represents the exposure data during groundwater restoration activities.

Table 7-7: Average and Maximum Doses for Willow Creek

Year	Average External (mrem/yr)	Maximum Individual External (mrem/yr)	Maximum Internal from Radon* (DAC-Hrs.)	Maximum Internal from Radon* (mrem/yr)	Maximum External + Internal (mrem/yr)
1995	10.5	11	8.48	21	32
1996	25	34	47.83	120	154
1997	11	11	6.75	17	28
1998	0	0	37.53	95	95
1999	0	0	34.17	85	85
2000	0	0	7.38	19	19
2001	27	84	5.28	13	97
2002	20.1	72	7.64	19	91
2003	4.5	7	0	0	7
2004	5	5	0	0	5
2005	1.5	5	0.01	0	5
Average	9.5	21	14	35	56

Notes: * Mean annual maximum based on reported DAC-Hours for Willow Creek and 2.5 mrem/DAC-hr

The resulting maximum values indicated in this table provide a reasonable estimate of expected doses to the maximally exposed worker at the proposed Ludeman Satellite facilities. It is also reasonable to assume that average worker doses would be considerably less than these maximums as only a limited number of employees would be working consistently near primary source areas such as the ion exchange columns or header house locations. Furthermore, the proposed Ludeman facilities have been designed with engineering controls to implement the ALARA principle including building ventilation and pressurized downflow ion exchange columns designed to significantly reduce radon concentrations in the Satellite facilities.

The use of pressurized downflow ion exchange (IX) columns and operating wellfields under pressure will result in the majority of radon in the production fluids remaining in solution and not being released to the environment. It is estimated that only 10% of radon-222 in production fluids IX columns will be released to the atmosphere. Vessel vents from the individual IX vessels will be directed to a manifold that is exhausted outside the building. This venting will minimize employee exposures. Small amounts of radon-222 may be released via solution spills, filter changes, IX resin transfer, reverse osmosis (RO) system operation during groundwater restoration, and maintenance activities. These will be small radon gas releases on an infrequent basis. The general

ventilation system in the Satellite facilities will further reduce employee exposure. Air in the Satellite facilities and header houses will be sampled for radon daughters as described in Section 5 to assure that concentration levels of radon and radon daughters are maintained as low as reasonably achievable (ALARA).

7.4 POTENTIAL NON-RADIOLOGICAL EFFECTS

The area within an 80-kilometer (km) (50-mile) radius of the proposed project area includes portions of eight counties in northeastern Wyoming (Albany, Campbell, Carbon, Converse, Johnson, Natrona, Niobrara, and Platte Counties). The proposed Ludeman Project is located in central Converse County. The nearest communities are Glenrock located southwest on State Highway 95, Douglas which is to the southeast on State Highway 93, and Casper located in Natrona County southwest of the proposed project on Interstate 25.

Section 2.3 discussed the population distribution for the 80 km radius around the proposed project. Figure 2.3-1 provides the sectorial population for the 16 compass sectors in concentric rings of 1, 2, 3, 4, 5, 10, 20, 30, 40, 50, 60, 70 and 80 km from the center of the proposed project. The population within two-miles of the project area boundary was estimated by locating occupied residences within two-miles using 2006 aerial photos and field reconnaissance in 2008. The nearest resident is approximately 0.8 km from the Leuenberger Satellite facility location. The nearest sensitive receptors (e.g., schools) are in the Town of Glenrock, located approximately 15.8 km from the nearest Satellite facility location.

NUREG-1569 requires that applicants provide estimates of concentrations of nonradioactive constituents in effluents at the points of discharge and provide a comparison with natural ambient concentrations and applicable discharge standards. There are two effluents expected from the proposed project.

- A gaseous and airborne effluent will consist of air ventilated from the plant building ventilation system and vented from process vessels and tanks. This gaseous effluent will contain radon gas as previously discussed in Sections 7.1.1 and 7.2.1. The gaseous and airborne effluent will not contain any non-radiological effluents. Nonradioactive airborne effluents at the proposed project will be limited to fugitive dust from access roads and wellfield activities. Fugitive dust emissions will be minimal and dust suppressants will be used if conditions warrant their use. Air quality impacts of operation of the proposed project were discussed in detail in Section 7.2.1.
- The liquid effluent will be managed in the deep disposal wells. The deep disposal wells will permanently dispose of liquid wastes and will be permitted under a Class I UIC Permit issued by the WDEQ. No routine liquid environmental

discharges, other than waste disposal via deep well injection, are planned and as such, no definable water related pathways for routine operations exist. There are no non-radiological impacts to public health expected due to the liquid effluents from the proposed project.

7.5 POTENTIAL EFFECTS OF ACCIDENTS

Accidents involving human safety associated with the ISR uranium production technology typically have far less severe consequences that accidents associated with underground and open pit mining methods. ISR provides a higher level of safety for employees and neighboring communities when compared to conventional mining methods or other energy related industries. Accidents that may occur would generally be considered minor when compared to other industries. Radiological accidents that might occur would typically manifest themselves slowly and are therefore easily detected and mitigated. The remote location of the proposed project and the low level of radioactivity associated with the process combine to decrease the potential hazard of an accident to the general public.

NRC has previously evaluated the effects of accidents at conventional uranium milling facilities in NUREG-0706 (USNRC, 1980) and specifically at ISR uranium facilities in NUREG/CR6733. These analyses demonstrate that, for most credible potential accidents, consequences are minor so long as effective emergency procedures and properly trained personnel are used. The proposed Ludeman Project facilities are consistent with the operating assumptions, site features, and designs examined in the NRC analyses in NUREG/CR-6733 (USNRC, 2001). Uranium One will develop emergency management procedures to implement the recommendations contained in the NRC analyses. Training programs will be developed to ensure that Uranium One personnel are adequately trained to respond to all potential emergencies. These training programs were discussed in detail in Section 5.

NUREG-0706 considered the environmental effects of accidents at single and multiple uranium milling facilities. Analyses were performed on incidents involving radioactivity and classified these incidents as trivial, small, and large. NUREG-0706 also considered transportation accidents. Some of the analyses in NUREG-0706 are applicable to ISR facilities, such as transportation accidents. NUREG/CR-6733 specifically addressed risks at ISR facilities and identified the "risk insights" that are discussed in the following sections.

7.5.1 Chemical Risk

NUREG/CR-6733 noted that the scope of the NRC mission includes hazardous chemicals to the extent that mishaps with these chemicals could affect releases of radioactive materials. Industrial safety aspects associated with the use of hazardous chemicals at the proposed Ludeman Project is regulated by the Wyoming Occupational Safety and Health Administration (OSHA).

7.5.1.1 Oxygen

Oxygen presents a substantial fire and explosion hazard. The design and installation of the oxygen storage facility is typically performed by the oxygen supplier and meets applicable industry standards. The oxygen will be delivered to the proposed Ludeman Project by truck and stored on site under pressure in a cryogenic tank in liquid form. The oxygen will be vaporized and will be added to the barren lixiviant upstream of the injection manifold.

Accident Prevention

Prevention methods utilized to minimize potential impacts to human health and safety from a release of oxygen include the following:

- The design and installation of underground and above-ground gaseous oxygen piping at Ludeman including material specifications, velocity restrictions, location and specifications for valves, and design specifications for metering stations and filters will be in accordance with industry standards contained in CGA G-4.4;
- Header houses will be equipped with an exhaust ventilation system to reduce the risks of O_2 accumulation in case of a leak;
- Oxygen monitoring will be conducted prior to entry into confined spaces where oxygen buildup could occur; and
- Normally closed solenoids will reduce the risk of O_2 leaks in the lixiviant injection piping.

Combustibles such as oil and grease will burn in oxygen if ignited. Uranium One will ensure that all oxygen service components are cleaned to remove all oil, grease, and other combustible material before putting them into service. Acceptable cleaning methods are described in CGA G-4.1.

Mitigation/Accident Response

Uranium One will develop procedures that implement emergency response instructions for a spill or fire involving oxygen systems. Emergency response procedures will include instructions in the following:

- Immediate notifications;
- Evacuation procedures;
- Perimeter establishment;
- Personal Protective Equipment requirements; and
- Reporting

7.5.1.2 Carbon Dioxide

The primary hazard associated with the use of carbon dioxide is concentration in confined spaces, presenting an asphyxiation hazard. Bulk carbon dioxide facilities are typically located outdoors and are subject to industry design standards. Floor level ventilation and carbon dioxide monitoring at low points will be performed to protect workers from undetected leaks of carbon dioxide within the Satellite facility.

The carbon dioxide storage system will consist of one 50-ton bulk liquid carbon dioxide pressure vessel tank at each Satellite supplied and maintained by the carbon dioxide supplier. The tank will be located outdoors and outside the Satellite facilities. All carbon dioxide deliveries and tank fillings will be performed by the supplier. Gaseous carbon dioxide is routed via carbon steel piping from the bulk storage tank to both the production and injection main lines.

Uranium One will incorporate recommendations concerning materials of construction for tanks and piping systems and the use of ventilation to control vapors in the event of a leak of carbon dioxide. The building HVAC system is designed for 3 air changes per hour with the capacity to expand to 6 air exchanges per hour. In addition, local exhaust fans will be installed along the outer plant wall to sweep vapors and gases near the floor level.

7.5.1.3 Sodium Sulfide

Sodium sulfide may be used as a reductant during groundwater restoration. Sodium sulfide is corrosive and will cause severe eye and skin burns. Routes of entry into the body include inhalation, ingestion, and contact with the skin. Under low pH conditions, sodium sulfide can react with water to liberate hydrogen sulfide gas.

Accident Prevention

Prevention methods utilized to minimize potential impacts to human health and the environment from a release of sodium sulfide include the following:

- Sodium sulfide can be flammable and contact with heat, flame, or other sources of ignition will be avoided;
- Sodium sulfide will be stored separately from incompatible chemicals such as hydrogen peroxide and sulfuric acid;
- Construction of all storage tanks, piping, and associated appurtenances will be in accordance with current industry standards;
- All tanks are enclosed limiting the amount of vapors that can escape to the atmosphere;
- Daily shift inspections of plant and chemical storage facilities are conducted for early detection of potential deficiencies;
- Containment will be provided for 110% of the total storage capacity constructed of chemically compatible materials; and
- Offloading procedures will be developed and implemented to ensure proper steps and precautions are followed during offloading into bulk storage areas.

Mitigation/Accident Response

Upon detection of a release of sodium sulfide, steps will be taken to stop or limit the extent of the release that can be performed without endangering the health of the responders. Uranium One will develop emergency response procedures for an accidental release of sulfuric acid and employees will be trained on those procedures. Emergency response procedures will include instructions in the following:

- Immediate notifications;
- Evacuation procedures;
- Perimeter establishment
- Personal Protective Equipment requirements;
- Site mitigation, neutralization, and cleanup; and
- Reporting

7.5.2 Radiological Risk

7.5.2.1 Tank Failure

A spill of the materials contained in the process tanks at the proposed project will present a minimal radiological risk. Process fluids will be contained in vessels and piping circuits within the Satellite facilities. The tanks at the proposed project will contain injection and production solutions, ion exchange resin and liquid waste.

NUREG/CR-6733 also assessed the potential dose from a catastrophic spill from an ion exchange column resulting in the release of the entire contents of the vessel and the resultant release of radon gas. Based on a number of assumptions, the predicted dose was 1.3 rem in a 30-minute period to a worker in the area. Any change to the Rn-222 concentration or exposure time has a linear affect on dose. For example, if the room size is doubled or the exposure time is halved, then the dose will be halved. NUREG/CR-6733 recommended that the use of ventilation or atmosphere-supplying respirators designed to protect against gases would be sufficient to mitigate doses that unprotected personnel should evacuate spill areas near ion exchange columns, and that ISR facilities maintain proper equipment, training, and procedures to respond to large lixiviant spills or ion exchange column failure.

Accident Prevention

The facilities will be designed to control and confine liquid spills from tanks should they occur. The Satellite facility building structure and concrete curb will contain the liquid spills from the leakage or rupture of a process vessel and will direct any spilled solution to a floor sump. The floor sump system will direct any spilled solutions back into the plant process circuit or to the waste disposal system. Bermed areas, tank containments, and/or double-walled tanks will perform a similar function for any process chemical vessels located outside the Satellite facility building.

All tanks will be constructed of fiberglass or steel. Instantaneous failure of a tank is unlikely. Tank failure would more likely occur as a small leak in the tank. In this case, the tank would be emptied to at least a level below the leaking area and repairs or replacement made as necessary. Other prevention methods include shift inspections of plant areas including tanks.

Mitigation/Accident Response

The proposed Ludeman Satellite facilities will be designed in accordance with standard industry building codes and will incorporate containment adequate to contain the contents of the largest tank in the facility at a minimum. As discussed in Section 4.1, area

ventilation will be provided to control concentrations of airborne radioactive material in the Satellite facilities. Finally, Uranium One will prepare spill response procedures, provide spill response equipment and materials, require the use of protective equipment, and will train employees in proper spill response methods. Emergency response procedures will include instructions in the following:

- Immediate notifications;
- Evacuation procedures;
- Perimeter establishment;
- Personal Protective Equipment requirements;
- Site mitigation, neutralization, and cleanup; and
- Reporting

7.5.2.2 Plant Pipe Failure

The rupture of a pipe within the Satellite facility will be easily detected by operating staff and can be quickly controlled. Spilled solution will be contained and managed in the same fashion as for a tank failure.

7.5.2.3 Radiological Release Reporting

Reporting of releases of source or byproduct material will be consistent with the requirements of 10 CFR 20 Subpart M. These reporting requirements are discussed in detail in Section 5.2.6 of this Technical Report.

7.5.3 Groundwater Contamination Risk

7.5.3.1 Lixiviant Excursion

Excursions of lixiviant at ISR facilities have the potential to contaminate adjacent aquifers with radioactive and trace elements that have been mobilized by the mining process. These excursions are typically classified as horizontal or vertical. A horizontal excursion is a lateral movement of mining solutions outside the mining zone of the ore-body aquifer. A vertical excursion is a movement of solutions into overlying or underlying aquifers.

The historical experience at other ISR uranium operations indicates that the selected indicator parameters and UCLs allow detection of horizontal excursions early enough that corrective action can be taken before water quality outside the exempted aquifer

boundary is degraded. As noted in NUREG/CR-6733, significant risk from a horizontal excursion would occur only if it persisted for a long period without being detected.

Accident Prevention

Uranium One will control the lateral movement of lixiviant by maintaining well field production flow at a rate slightly greater than the injection flow. This difference between production and injection flow is referred to as process bleed. The bleed solution will either be recycled in the plant or sent to the liquid waste disposal system. When process bleed is properly distributed among the many mining patterns within the wellfield, mining solutions are contained within the monitor well ring.

Uranium One will monitor for lateral movement of lixiviant using a horizontal excursion monitoring system. This system consists of a ring of monitor wells completed in the same aquifer and zone as the injection and production wells. Monitor wells will be installed as discussed in Section 5.7.8. Monitor wells will be sampled semiweekly for approved excursion indicators. Corrective actions will be taken if early signs of lixiviant migration are detected prior to reaching excursion status.

Vertical excursions can be caused by improperly cemented well casings, well casing failures, improperly abandoned exploration wells, or leaky or discontinuous confining layers. Uranium One will prevent vertical excursions through aquifer testing programs and rigorous well construction, abandonment, and testing requirements. Aquifer testing is conducted before mining wells are installed to detect any leaks in the confining layers. Aquifer test reports are submitted to the WDEQ for review and approval before wellfield operation may proceed. Well construction and integrity testing will be conducted in accordance with WDEQ regulations and methods approved by NRC and WDEQ. Construction and integrity testing methods were discussed in detail in Section 3.1. Well abandonment is conducted in accordance with methods approved and monitored by the WDEQ and discussed in detail in Section 6.2.

Uranium One will monitor for vertical excursions in the overlying and underlying aquifers using monitor wells. These wells will be located within the wellfield boundary at a density of one well per four acres. Shallow monitor wells will be sampled semimonthly for approved excursion indicators.

Mitigation\Accident Response

Corrective actions and excursion response will be conducted as described in Section 5.7.8.

7.5.4 Wellfield Spill Risk

The rupture of an injection or recovery line in a wellfield, or a trunkline between a wellfield and the Satellite facilities, would result in a release of injection or production solution which would contaminate the ground in the area of the break. All piping from the proposed project Satellite facilities, to and within the wellfield will be buried for frost protection. Pipelines will be constructed of high density polyethylene (HDPE) with butt welded joints, or equivalent. All pipelines will be pressure tested at operating pressures prior to final burial and production flow and following maintenance activities that may affect the integrity of the system.

Spill Prevention

Each wellfield will have a number of header houses where injection and production wells will be continuously monitored for pressure and flow. Individual wells may have high and low flow alarm limits set. All monitored parameters and alarms will be observed in the control room via the computer system. In addition, each header house will have a "wet building" alarm to detect the presence of any liquids in the building sump. High and low flow alarms have been proven effective in detection of significant piping failures.

Occasionally, small leaks at pipe joints and fittings in the header houses or at the wellheads may occur. Until remedied, these leaks may drip process solutions onto the underlying soil. Uranium One will implement a program of continuous wellfield monitoring by roving wellfield operators and will require periodic inspections of each well that is in service.

Mitigation/Spill Response

Following repair of a leak, Uranium One will require that the affected soil be surveyed for contamination and the area of the spill documented. If contamination is detected, the soil is sampled and analyzed for the appropriate radionuclides. Contamination may be removed as appropriate.

Uranium One will develop a response plan for wellfield spills that will include:

- Notification procedures;
- Spill containment and recovery procedures;
- Post spill sampling and cleanup procedures; and
- Reporting procedures

7.5.5 Transportation Accident Risk

Uranium-loaded resin shipments from the proposed Satellite facilities to the Willow Creek Project CPP will utilize the following transportation routes. All transportation and access roads are currently in place. Discussion on transportation impacts can be found in Section 4.2 of this TR.

Shipments of uranium-laden resin from the proposed Ludeman Satellite facilities to the Willow Creek Central Processing Facility for elution, precipitation and drying of uranium and return shipments of barren eluted resin will utilize the below routes. Dependent on road construction activities and/or weather conditions 11e.(2) shipments will utilize either the Primary or Alternate transportation routes.

- Primary Route: Ludeman to Casper to Willow Creek CPP ≈(137 miles)
  - Utilizing WY 95, WY 93, I-25 N, HWY 259, HWY 387, HWY 192, Streeder Road and Irigaray Road; and
- Alternate Route: Ludeman to Douglas to Willow Creek CPP ≈(158 miles)
  - Utilizing WY 95, WY 93, HWY 59, HWY 387W, HWY 50, Black and Yellow Road and Irigaray Road.

With regard to 11e.(2) byproduct material transportation, Uranium One (SUA-1341) currently has an agreement with the licensed Pathfinder Mine Corporation (Shirley Basin WY) Facility to include shipment of any 11e.(2) materials.

- Primary Route: Ludeman to Casper to Shirley Basin ≈(100 miles)
  - Utilizing WY 95, I-25 N, HWY 220, HWY 487; and
- Alternate Route: Ludeman to Douglas to Wheatland to Medicine Bow to Shirley Basin ≈(195 miles)
  - Utilizing WY 95, I-25 S, HWY 34, HWY 30, HWY 487

7.5.5.1 Potential Accidents Involving Ion Exchange Resin Shipments

A potential transportation risk associated with operation of the proposed project is the transfer of the ion exchange resin to and from an offsite central plant. Loaded ion exchange resin will be transported in a tanker truck. It is currently anticipated that up to eight loads of uranium-laden resin may be transported for elution and up to eight loads of barren eluted resin may be returned on a daily basis depending on the current operations of the Satellite facilities. The transfer of resin will occur on a combination of private, county and State roads. For shipments of ion exchange resin to an offsite central

processing facility, NRC determined that the probability of an accident involving such a truck was 0.009 in any year[18].

Resin or eluate shipments will be treated similarly to yellowcake shipments in regards to Department of Transportation (DOT) and USNRC regulations. Shipments will be handled as Low Specific Activity (LSA) material for both uranium-laden and barren resin. General shipping procedures are outlined as follows:

- The resin, either loaded or eluted, will be shipped as "Exclusive Use Only". This will require the outside of each container or tank to be marked "Radioactive LSA" and placarded on four sides of the transport vehicle with "Radioactive" diamond signs;
- A bill of lading will be included for each shipment (including eluted resin). The bill of lading will indicate that a hazardous cargo is present. Other items identified shall be the shipping name, ID number of the shipped material, quantity of material, the estimated activity of the cargo, the transport index and the package identification number;
- Before each shipment of loaded or barren eluted resin, the exterior surfaces of the tanker will be surveyed for contamination. In addition, gamma exposure rates will be obtained from the surface of the tanker and inside the cab of the tractor. All of the survey results will appear on the bill of lading; and
- Properly licensed and trained drivers will transport the resin between the proposed project Satellite and offsite central processing facilities.

Accident Prevention

Actions taken to prevent accidents involving shipments of ion exchange resins include the following:

- Properly licensed and trained drivers will transport the resin between the proposed project and the Willow Creek Central Plant facility;
- Trucks and tanker trailers used to transport ion exchange resins will be maintained in good operating condition;
- Inspections will be conducted of the tanker truck prior to shipment of ion exchange resins. Transportation equipment will be taken out of service if any significant deficiencies are identified that could affect safe operation and transport and will not be place back into service until the deficiencies are corrected; and
- Transport of ion exchange resin will only occur on maintained gravel or paved roads and will not occur during extreme or unsafe weather conditions.

Mitigation/Accident Response

Uranium One will develop an emergency response plan for transportation accidents to or from the proposed project. Uranium One personnel will receive training for responding to a transportation accident. The emergency response plan will include descriptions of the following provisions:

- DOT regulations;
- Carrier Emergency Response Procedures;
- Spill kits;
- Immediate response and notification;
- Accident scene response;
- Spill cleanup;
- Concluding activities;
- Review of accident documentation;
- Review of monitoring and sampling data;
- Site abandonment; and
- Reporting

The worst case accident scenario involving resin transfer transportation would be an accident involving the transport truck and tanker trailer when carrying uranium-laden resin where all of the tanker contents were spilled. Because the uranium is ionically bonded to the resin and the resin is in a wet condition during shipment, the radiological and environmental impacts of such a spill are minimal. The radiological and environmental impact of a similar accident with barren, eluted resin would be less significant. The primary environmental impact associated with either accident would be the salvage of soils impacted by the spill area and the subsequent damage to the topsoil and vegetation structure. Areas impacted by the removal of soil would be revegetated.

In the event of a transportation accident involving the resin transfer operation, Uranium One will institute its emergency response plan for transportation accidents. To minimize the impacts from such an accident, the following procedures will be followed:

- Each truck will be equipped with a communication device that will allow the driver to communicate with either the shipper or receiver. In the event of an accident and spill, the driver will be able to communicate with either site to obtain help;
- A check-in and check-out procedure will be instituted where the driver will notify the receiving facility prior to departure from his location. If the resin shipment fails to appear within a set time, an emergency response team will respond and

search for the vehicle. This system will assure reasonably quick response time in the case that the driver is incapacitated in an accident;

- Each resin transport vehicle will be equipped with an emergency spill kit which the driver can use to begin containment of any spilled material. The kit will include plastic sheeting to cover spilled material until cleanup operations can begin;
- Both the shipping and receiving facilities will be equipped with emergency response kits to quickly respond to a transportation accident; and
- Personnel and truck drivers will have specialized training to handle an emergency response to a transportation accident.

7.5.5.2 Potential Accidents Involving Shipments of Process Chemicals

It is estimated that approximately four bulk chemical, fuel, and supply deliveries will be made per working day throughout the operational life of the project. Types of deliveries will include carbon dioxide, oxygen, and fuel. All shipment will be made in accordance with the applicable DOT hazardous materials shipping provisions.

7.5.5.3 Accidents Involving Radioactive Wastes

Low level radioactive 11.e(2) by-product material or unusable contaminated equipment generated during operations will be transported to a licensed disposal site. Because of the low levels of radioactive concentration involved, these shipments are considered to have minimal potential environmental impact in the event of an accident. Shipments are generally made bulk in sealed roll off containers in accordance with the applicable DOT hazardous materials shipping provisions.

7.5.6 Fires and Explosions

The fire and explosion hazard of the Satellite facilities will be minimal as the plants do not use flammable liquids in the recovery process and building and equipment materials are largely made up of non-flammable materials such as steel or concrete. Natural gas used for building heat would be the primary source for a potential fire or explosion. In the Satellite facilities the uranium will be adsorbed on ion exchange resins. An explosion, therefore, would not appreciably disperse the uranium to the environment.

In the wellfields, injection and recovery well piping systems are manifolded for ease of operational control. Piping manifolds, submersible pump motor starters/controllers, and gaseous oxygen delivery systems are situated within electrically heated, all weather buildings. These are commonly referred to as "headerhouses". An accumulation of

gaseous oxygen would be the primary source for a potential fire or explosion. Such an event could result in the rupture of a leaching solution pipeline within the building and a spill of leaching solution.

Fire Prevention

Prevention methods utilized to minimize potential impacts to human health and the environment from fire or explosion scenarios discussed above include the following:

- Spilled liquids or slurries would be confined to the building sump or to the runoff control system;
- Both the gaseous oxygen and primary leaching solution lines entering each headerhouse are equipped with automatic low pressure shut off valves to minimize the delivery of oxygen to a fire or of liquids to a spill;
- Additionally, each headerhouse is equipped with a continuously operating exhaust fan that would assist in preventing the build-up of oxygen in the building; and
- Procedures will be in place for confined space work or hot work for monitoring of oxygen build-up prior to start of work.

Mitigation/Emergency Response

Automatic detection and alarm systems along with sprinkler systems will be installed in the facilities at the proposed project. Fire extinguishers will be placed at accessible locations in all buildings and vehicles for quick response and training will be provided for appropriate personnel in use of fire extinguishers. Uranium One personnel will receive training for responding to a fire or explosion. The emergency response plan will include descriptions of the following provisions:

- Notification and evacuation procedures;
- Personal Protective Equipment;
- General fire fighting safety rules;
- Reporting procedures;
- Electrical and gas emergencies;

7.5.7 Natural Disaster Risk

NUREG/CR-6733 considered the potential risks to an ISR facility from natural disasters. Specifically, the risk from an earthquake and a tornado strike were analyzed. NRC determined that the primary hazard from these natural events was from dispersal of yellowcake from a tornado strike and failure of chemical storage facilities, resulting in

the possible reaction of process chemicals. There will be no processing of uranium to yellow cake at the proposed project and the only chemicals in use will be oxygen and carbon dioxide. NUREG/CR-6733 recommended that licensees follow industry best practices during design and construction of chemical facilities.

The proposed project is located in Converse County Wyoming, in which 37 tornado touch downs were recorded in a period from 1950 through 2003 (WSCO, 2007). Of those, 34 tornadoes were classified as FO (with wind speeds of 40-72 miles per hour and described as a gale tornado) or F1 tornadoes (described as moderate with wind speeds of 73-112 miles per hour). Three of the 37 tornadoes were classified as F2 with wind speeds of 113 to 157 miles per hour and described as significant tornadoes. Based on the Fujita Scale, the type of damage that can be expected from an F2 tornado is roof damage, unsecured mobile homes pushed off foundations, and light structures severely damaged or destroyed. Based on maximum wind speed probability, the eastern third of the state can expect a tornado between 10,000 and 100,000 years,

NUREG-0706 estimated the probability of occurrence of a tornado in the area in which the project is located is about 3×10^{10} per year. The area was categorized as Region 3 in relative tornado intensity. For this category, the wind speed of the design tornado was 240 mph (F4 tornado), of which 190 mph is rotational and 50 mph is translational. The proposed structures are not designed to withstand a tornado of this intensity.

Mitigation and Emergency Response

NUREG/CR-6733 concluded that tornado risk is very low at uranium ISR facilities and that no design or operational changes were required to mitigate the risk. One recommendation was that chemical storage tanks be located sufficiently far apart that leaks caused by tornado damage would not result in chemical reactions. Uranium One will institute procedures and provide instructions to operating personnel for response and mitigation of natural disasters and any associated spills of radioactive materials. Emergency response procedures will include:

- Notification to personnel of potential severe weather;
- Evacuation procedures;
- Damage inspection and reporting; and
- Cleanup and mitigation of spills of radioactive materials or chemicals

7.6 POTENTIAL ECONOMIC AND SOCIAL EFFECTS OF CONSTRUCTION AND DECOMMISSIONING

7.6.1 Construction

The construction and decommissioning phases of the proposed project will cause a moderate impact to the local economy, resulting from the purchases of goods and services directly related to construction activities and increased demand for housing and other services. Potential impacts to community services such as roads, housing, schools and energy costs would be minor in the nearby towns of Rolling Hills (a small town located west of the Project on State Highway 95), Glenrock (west on State Highway 95), Douglas (southeast on State Highway 93), and Casper (the nearest regional economic hub).

In the first year, project development will be construction only and will create approximately 65 jobs directly related to construction activities. Based on local experience, an estimated 50 percent of the peak year construction/decommissioning workforce would be persons already living in Converse County and Natrona County. Other workers may come from outside the local area and will either re-locate for the term of the project or will be long-distance commuters working for extended shifts.

Most construction work available to the local construction labor pool consists of temporary contract work that varies in duration, depending on the scope of each construction project. Further, the number of unemployed construction workers does not represent the number of workers that would be available to the proposed project from the local construction labor pool. The number is an annual average that does not take into account monthly variations in the available construction labor pool from construction start-ups and completions. Contractors for projects located in central Wyoming typically hire the local construction labor pool. The actual number of construction workers available for the proposed project would potentially draw from the Converse County and Natrona County construction combined labor pool of 3,142 (January, 2009 Wyoming Department of Employment).

7.6.2 Operations Workforce

The directly employed operations workforce will grow from approximately 14 persons in the second year of operations to approximately 48 during the peak work years. The peak includes a period when all three Satellite facilities and multiple wellfields would be actively operating. The peak operations period is transient and not permanent (lasting approximately three years with average annual direct employment at 44-48 jobs). It is assumed that the majority of operations personnel would be generated from the Casper,

Glenrock, Douglas area or would be temporary personnel from outside the area. It is not known how many of the permanent required operations workforce would be hired from outside of Converse and Natrona Counties. In the event that the entire operations workforce and their families relocated to the counties, the population increase would be a maximum of 113, based on the 2006-2008 average household size of 2.46 in Wyoming (U.S. Census Bureau). This increase would account for 0.1 percent of the population of Converse and Natrona Counties, and is smaller than the projected annual growth rate. Therefore, there would be little to no effect to the vacancy rates of any type of housing in Converse or Natrona County area.

7.6.3 Potential Effects to Housing

At its peak levels of employment, the proposed project is estimated to produce approximately 164 total jobs in Wyoming. This includes jobs created directly or indirectly by the project or induced by related household expenditures. Many of the jobs will be ongoing over the life of the project (such as the number of persons directly employed by the operator or its contractors for ongoing construction). Others will be tied to specific phases, such as construction or decommissioning, and will be shorter-term rather than on-going. As a result, the total number of jobs is estimated to fluctuate from year to year.

Compared to the rest of the nation, unemployment rates are low in Converse and Natrona Counties, the area most likely to be affected by the increased number of jobs and associated housing demand. These counties are however beginning to feel the effects of the national recession. In June 2009, the unemployment rate in Converse County was 5.2% (compared to 2.8% in June 2008) and 6.1% in Natrona County (compared to 3.0% in June 2008). In June 2009, the national unemployment rate was 9.5%. The average unemployment rate between July 2008 and June 2009 was 7.6% in the nation, but it remained below 4% in Converse and Natrona Counties. It is anticipated that Converse and Natrona Counties will continue to have lower unemployment rates than the state and the nation. In part due to the relatively lower unemployment in the local area and the small population base, it is assumed that the supply of available workers is limited locally and that many (and possibly most) of the employees needed to fill the projected new local jobs will come from outside Converse and Natrona Counties.

At the peak of direct employment numbers (in 2016), the proposed project would account for approximately 96 new jobs. Assuming each new job resulted in a separate demand for housing, 96 housing units would be needed. Homeowner vacancy rates were 2.3% in Converse County and 1.5 percent in Natrona County, according to the 2000 census (the most recent for which such census data are available at the county level). In a multiple listing service (MLS) internet web search on March 26, 2009, there were 420 listings for houses priced at $300,000 or less in Glenrock (27), Douglas (36), and Casper (357). In

July 2007, Converse County had an estimated two vacant units out of 424 total rental units (.47 percent rental vacancy rate) and Natrona County had 44 vacant rental units (1.07 percent rental vacancy rate). The lack of available rental units in Converse County was reported in the Douglas Budget on November 26, 2008. Many people who desire rental units have been staying in hotels/motels for weeks and months at a time.

Based on these data, there would be adequate supply of houses available for sale for needs associated with direct employment from the proposed project and a very limited supply of rental units. It is assumed that the supply of houses for sale that are in good "move-in" condition and in desirable areas may be less than the total number of houses for sale, but with more than 400 available (as of March 2009), there would be sufficient numbers for the estimated 96 new homes needed for direct employment numbers. Some of the employees will likely be hired from the existing local labor pool and therefore 96 homes may overestimate housing demand from direct employment. Based on current trends, it is anticipated that at least some workers will continue to have a residence outside of Converse and Natrona Counties and will be commuting long distance for shift work. While on site they would likely be staying in rentals or hotels/motels. Unless additional rental units are created, this will exacerbate the existing tight rental market.

The total of all new direct, indirect, and induced jobs estimated by the IMPLAN analysis (refer to Section 9.0) are for the state of Wyoming, not just Converse and Natrona Counties. If all 164 new direct, indirect, and induced jobs (at the peak of total employment in 2016) were in Converse and Natrona Counties, there would be adequate housing stock to purchase (based on the March 2009 homes for sale), but rental housing would be inadequate and put additional strains on hotels and motels.

7.6.4 Potential Effects to Services

The estimated total of 164 direct, indirect, and induced jobs of the peak employment year for the proposed project would result in a total population increase of 397 persons, based on average household size in Wyoming of 2.42 in 2006 (U.S. Census estimate) and assuming that all of the jobs are filled with persons not already living in Wyoming..

Although the IMPLAN analysis (described in Section 9) study area was for the entire state of Wyoming, for purposes of analyzing the impacts to schools and other public services, all 164 jobs were projected to result in population increases to Converse and Natrona Counties. This overestimates the likely potential for impacts for those two counties. The addition of 397 persons would be an increase of less than one percent to the total combined 2007 estimated population of 84,618 for Converse and Natrona Counties.

Children between the ages of five and 19 constituted approximately 20 percent of total estimated population in Converse and Natrona Counties in 2007. Using 20 percent as the

ratio for school age children, there would be approximately 79 school age children anticipated from the projected increase in employment.

Converse School District No. 1 in Douglas was adding new facilities in 2008-2009 and was anticipating it could handle 350 additional students in grades K-5 and 250 additional students in Middle and High School. Converse School District #2 in Glenrock was under capacity in 2008 and would be able to increase enrollment by another 200 students without additional expansion (other than what has already been planned or recently completed). The Natrona County School District (primarily in the Casper area) has approximately 11,500 students.

A total increase of less than one percent to the total population of Converse and Natrona County is not likely to create a significant impact on other public services such as fire, police, water, and utilities.

7.6.5 Potential Effects to Traffic

The primary transportation route to the proposed Ludeman Project from nearby communities is on State Highway 95, which connects the license area to the community of Glenrock along Interstate 25 to the west and State Highway 93, which connects to Douglas to the east. The City of Casper is located approximately 36 miles west of the project area on State Highways 95 and Interstate 25. The Town of Douglas is approximately 18 miles southeast on State Highway 93, and also lies along the Interstate 25 corridor. In 2007 the Annual Average Daily Traffic counts along the 18-mile segment of State Highway 95 between Glenrock and the State Highway 93 junction is 50 vehicles (WYDOT, personal communication, October 23, 2008). Several private access roads extend south from State Highway 95 to access existing agricultural, residential, and oil and gas facilities in the project area. The Annual Average Daily Traffic counts at the intersection of State Highway 95 and County Road 26 (Leuenberger Lane, used to access residential and ranch facilities) is 260.

The highest levels of project-related traffic would be from the operations workforce, and assuming there would be an average of one employee per vehicle, per one-way vehicle trip, there could be an increase of 5.4 percent in daily traffic along the highway. This 5.4 percent (10.8 percent for two trips per day) increase is well below the 25 percent threshold generally used for predicting significant effects to a transportation system.

Equipment needed for construction and installation of the proposed facility would include heavy equipment (cranes, bulldozers, graders, trackhoes, trenchers, and front-end loaders), and heavy-and light-duty trucks. It is anticipated that heavy equipment will be transported primarily to the site during off-peak traffic hours.

Transportation of IX resin would be made in exclusive use transport vehicles to the Willow Creek central plant for further processing. Loaded ion exchange resin will be transported from the proposed project in a tanker truck. It is currently anticipated that up to four loads of uranium-laden resin may be transported for elution and up to four loads of barren eluted resin may be returned on a daily basis, resulting in approximately 2,920 shipments of IX resin per year. This level of traffic would not significantly affect the project-related traffic compared to the commuting traffic associated with the project workforce.

Transportation of 11(e).2 byproduct material will be made in exclusive-use transport vehicles off-site to a licensed disposal facility. A disposal agreement is in place under the SUA-1341 License Application with the Pathfinder Mines Corp. (PMC) Shirley Basin facility. The Shirley Basin facility is located approximately 100 highway miles from the proposed project. The expected transport route to the PMC facility will be west on State Highway 95, south on State Highway 93, south on Interstate 25, west on State Highway 220, and south on State Highway 487 to the PMC facility access road. The expected annual byproduct material production rate for the proposed project is approximately 250 cubic yards. Based on the use of covered roll-off containers with a nominal capacity of 20 cubic yards, Uranium One expects 12 to 13 byproduct material shipments per year. This level of traffic would not significantly increase the project related traffic compared to the estimated commuting and truck traffic associated with the project.

Transportation of nonradioactive solid waste will be made using a contract waste hauling company to a licensed disposal facility. The preferred alternative disposal site is the Glenrock disposal facility located in Glenrock, Wyoming due to proximity to the proposed project site. The Glenrock facility is located approximately 3 highway miles from the proposed project. The expected transport route to the Glenrock disposal facility will be west on State Highway 95 to Rolling Hills. The expected annual nonradioactive solid waste production rate for the proposed project is 2,000 cubic yards. Typical contract waste haulage vehicles range in capacity from 20 to 40 cubic yards. Based on a conservative assumption of the use of haulage vehicles with a nominal capacity of 20 cubic yards, Uranium One expects 100 nonradioactive solid waste shipments per year, or an average of approximately 2 shipments per week. This level of traffic would not significantly increase the project-related traffic compared to the estimated commuting and truck traffic associated with the project.

On-site road maintenance will include periodic grading of the primary access roads, snow plowing, applying water or other agent(s) for dust control, and regular inspections to ensure erosion control measures are adequate.

7.6.6 Economic Impact Summary

It is anticipated that the overall effect of the proposed facility operations on the local and regional economy would be beneficial. Purchases of goods and services by the mine and mine employees would contribute directly to the economy. Local, state, and the federal governments would benefit from taxes paid by the mine and its employees. Indirect impacts, resulting from the circulation and recirculation of direct payments through the economy, would also be beneficial. These economic effects would further stimulate the economy, resulting in the creation of additional jobs. Beneficial impacts to the local and regional economy provided by the proposed Ludeman Project operation would continue for the life of the facility, estimated to be 14 years for the plant and wellfield construction, operation and decommissioning. Economic impacts of the proposed operation are discussed in detail in Section 9.

7.7 ENVIRONMENTAL JUSTICE

In compliance with Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, ethnicity and poverty status in the vicinity of the proposed actions have been examined and compared to city, regional, state, and national data to determine if any minority or low-income communities could potentially be disproportionately affected by implementation of the proposed action. Similarly, in compliance with Executive Order 13045 – *Protection of Children from Environmental Health Risks and Safety Risks,* the distribution of children and locations where numbers of children may be disproportionately high in the vicinity of the proposed actions was determined to ensure that environmental risks and safety risks to children are addressed.

Three criteria must be met for impacts to minority/low income communities to be considered significant. First, there must be one or more populations within the region of influence. Second, there must be adverse (or significant) impacts from the proposed action. Finally, the population under investigation must bear a disproportionate burden of those adverse impacts. If any of these criteria are not met, then impacts with respect to environmental justice or protection of children are not significant.

According to the environmental justice guidance provided by the Nuclear Regulatory Commission, *"percentage differences greater than 20 percentage points may be considered significant, and if either the minority or low-income population percentage in the radius of influence exceeds 50 percent, environmental justice should be considered in greater detail"* (Nuclear Regulatory Commission 2008:6.3). An examination of census blocks indicates there are several areas within the proposed project study area that contain a concentration of minority populations over 40 percent. However, these localities are scattered throughout the study area, and generally consist of only one or a

few households. The proposed project study area will not disproportionately affect minorities or low-income communities.

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8 ALTERNATIVES

8.1 DESCRIPTION OF ALTERNATIVES

NRC regulations 10 CFR Part 51 and guidance at NUREG-1569 require this chapter to provide realistic alternatives to the Proposed Action of the proposed Ludeman Project (proposed project). These alternatives include but are not limited to (1) the no-action alternative; (2) the proposed action; (3) reasonable alternatives although deemed not suitable.

Currently, the process of evaluating potential alternatives within the confines of the 10 CFR Part 51 involves the consideration of two (2) types of alternatives: (1) primary and (2) secondary.

For purposes of this TR, the alternatives assessed and the data and analyses included herein are identical to those discussed in Section 2 of the ER.

8.1.1 No-Action Alternative

Under the provisions of the National Environmental Policy Act (NEPA), Uranium One is required to assess the No-Action Alternative. Under the no-action alternative, the NRC would not approve the proposed project combined Source and 11e.(2) Byproduct Materials License Application to construct, operate, and decommission the proposed project. Uranium ISR would not occur at the proposed project and, accordingly, none of the associated potential impacts identified and analyzed as part of the proposed action.

The No-Action Alternative would result in significant financial impacts to Uranium One, Converse County, Wyoming and the surrounding communities. Uranium One has invested significant resources to develop the proposed project that would be irretrievably lost under the no-action alternative. In addition, the no-action alternative would adversely affect the economic growth of Campbell, Natrona and Converse Counties. As discussed in further detail in Section 9, the proposed project is expected to provide significant positive economic impacts to the local and State economies, including stakeholders with which Uranium One has surface leases and which own the mineral rights in the proposed project area.

A decision to not issue an NRC combined Source and 11e.(2) Byproduct Materials License to Uranium One would leave a large resource unavailable for domestic energy production. Uranium One is continuing to develop estimates of the reserves at the proposed Ludeman Project and currently estimates the resource is 6.3 million pounds U_3O_8.

According to the U.S. Energy Information Administration (EIA), the total domestic production of U_3O_8 in the first quarter of 2011 was only 1.06 million pounds, down 7 percent from the previous quarter. In 2010, total domestic production was only 4.23 million pounds in contrast with domestic demand for approximately 47 million pounds U_3O_8 (EIA 2011). The proposed project represents an important new source of domestic uranium supplies that are essential to provide a continuing source of fuel to power generation facilities. This additional domestic uranium production will help alleviate U.S. dependency on foreign suppliers located in Canada, Russia, Kazakhstan and Australia among others.

Under the No-Action Alternative, baseline conditions will be influenced by natural processes and by other industrial, commercial, and residential development in the area. Groundwater in the ore-bearing zone will remain unsuitable for drinking due to the high levels of naturally occurring radionuclides and other constituents described in Section 2.7 of this TR.

8.1.2 Proposed Action

As described in Section 3 of this TR, the Proposed Action involves Uranium One utilizing ISR processes and methodologies to recover uranium from known ore bodies. The ISR process is accomplished by installing a series of injection and production wells. Utilizing the injection wells, a carbonate leaching solution, or barren lixiviant, is injected into the ore body. To promote flow across the mineralized areas, corresponding production wells are used to pump water from the ore body, and allow for the collection of the uranium bearing carbonate leach, or pregnant lixiviant, solution. Once the pregnant lixiviant reaches the Satellite facility, the uranium is removed from the lixiviant through the use of pressurized downflow ion exchange columns. Once the resin in an individual exchange column can no longer hold additional uranium molecules, the resin from that vessel is moved to another vessel where the uranium molecules are eluted from the resin. After the elution process is complete, the resin is moved back into the ion exchange column and re-introduced to the ion exchange process. After the lixiviant has passed through the ion exchange system, the solution is re-fortified with a concentrated carbonate solution, making barren lixiviant, and can then be recycled to the injection wells for further mining.

The next phase of the process is the further concentration of the uranium rich solution to create a marketable product. Uranium from ion exchange resins at the proposed Ludeman Satellite facilities will be transported and subsequently processed at the Willow Creek Central Processing Facility, located in Johnson County. This is accomplished by precipitating the dissolved uranium out of the eluant solution, dewatering the uranium solids, and drying the uranium slurry. The dried uranium product, yellowcake, is then packaged to allow safe transportation.

Initial wellfield(s) for the Proposed Action are developed concurrently with construction of the proposed Satellite facilities and ancillary ISR facilities. Groundwater restoration will take place in the initial wellfield(s) when the uranium resource has been adequately depleted and, simultaneously, additional sequential wellfield developed will occur. The goal of groundwater restoration will be to return the concentration of an identified constituent in the production zone to an NRC-approved background concentration or to a relevant MCL, whichever is higher, or to an Alternate Concentration Limit (ACL) approved by NRC pursuant to 10 CFR Part 40, Appendix A, Criterion 5(B)(5) using Best Practicable Technology (BPT). Successful groundwater restoration was demonstrated within the proposed project area by the Leuenberger pilot ISR facility. A detailed description of the Proposed Action is presented in Section 3 of this TR.

Following groundwater restoration activities, all injection and recovery wells will be reclaimed using mandated plugging and abandonment procedures. In addition, a sequential land reclamation and re-vegetation program will be implemented on the site. This surface reclamation (i.e., decommissioning and decontamination (D&D) will be performed on all disturbed areas, including the Satellite facilities, wellfields, ponds and roads such that upon license termination, the site will be released for unrestricted use. Uranium One will maintain financial responsibility for groundwater restoration, facility decommissioning and surface reclamation until NRC approves license termination and site release. Financial assurance is discussed in Section 6 of this TR.

8.1.3 Reasonable Alternatives Considered But Rejected

8.1.3.1 Conventional Uranium Milling and Underground Milling

As a part of the alternatives analysis conducted by Uranium One, three uranium recovery alternatives were considered. Underground and open pit mining with associated milling facilities and heap leach facilities represent the three currently available alternatives to ISR operations for the uranium deposits in the proposed project area. These alternatives were eliminated based on economics, health, safety, and environmental impacts in relation to the proposed project ore body.

Conventional uranium recovery methods are not suitable for the recovery of lower grade ores due to the significant capital costs associated with the construction and operation of a conventional mine and associated mill. Further discussion of conventional mining methods is provided below.

8.1.3.2 Open Pit Mining

Open pit mining requires the removal of all material covering the orebody. This overburden must be removed and stockpiled to allow removal of the uranium-bearing ore. Once removed, the ore must be transported to a conventional uranium mill for further processing and uranium extraction.

Open pit mining of the relatively low grade proposed project ore would require a capital investment that is not supported by the current uranium market. The nearest conventional mill with an operating license that could receive uranium ore for toll milling is the Denison Mines White Mesa Mill located in Blanding, Utah, nearly 600 miles away. The combination of capital costs to develop an open pit mine at the proposed project, the operating and maintenance costs to mine the ore, and the transportation costs to Blanding, Utah far exceed the current value of the ore as a feedstock for White Mesa. The nearest conventional uranium mill, Kennecott Uranium Corporation's Sweetwater Mill, located in the Great Divide Basin in Wyoming, is currently licensed for operations but is on standby status. However, if the Sweetwater Uranium Mill was currently licensed for operation, similar economic factors would preclude mining the proposed project deposit under current and future reasonably projected uranium market conditions.

Environmental factors must also be considered in addition to the economic factors for open pit mining. Open pit mining would produce large piles of waste rock that would permanently alter the topography of the proposed project site. In addition, substantial dewatering of the pit on the order of several thousand gpm would be required to depress the potentiometric surface to allow mining. Large quantities of groundwater with naturally elevated radium-226 and uranium would be discharged requiring treatment and necessary subsequent disposal of a radioactive solid waste. Moreover, the necessary dewatering process would consume large volumes creating the need for groundwater.

8.1.3.3 Underground Mining

Underground mining of the proposed project deposit would involve sinking mine shafts to the vicinity of the orebodies, horizontally driving crosscuts and drifts to the ore bodies at different levels, physically removing the ore and transporting the mined ore to a conventional uranium mill for further processing. The economic factors involved with this alternative are similar to those for ores mined from an open pit; although depending on depth to the deposit can be significantly more costly and dangerous for workers.

Additionally, from an environmental perspective, underground mining in conjunction with the associated milling process involves significantly higher risks to employees, the public, and the environment. Radiological exposure to the personnel in these processes is increased, not only from the mining process but also from milling and the resultant mill

tailings. The milling process generates a significant amount of waste relative to the amount of ore processed. Extensive mill tailings impoundments are needed for the disposal of these wastes. The potential non-radiological health and safety risks to workers as well as the environmental impacts associated with underground mining are recognized as being considerably greater than those associated in ISR operations.

8.1.3.4 Heap Leaching

As an alternative to conventional milling, uranium is extracted from low-grade ore by heap leaching. This may be done if the uranium content is too low for the ore to be transported to and economically processed at a uranium mill. The low-grade ore is crushed ore then mounded above grade on a leaching pad with a liner. The heap leaching pads must be constructed with the same standards as conventional mill tailings impoundments including a double liner per 10 CFR Part 40, Appendix A. A sulfuric or alkaline leaching agent is introduced on the top of the pile via a sprinkler or drip system which percolates down until it reaches the liner below, where it is captured and pumped to a processing facility. After completion of the leaching process (within months to years), the leached ore is either left in place, or removed to a disposal site, and new ore is placed on the leach pad (so-called on/off scheme, or dynamic heap leaching). Though impacts from heap leaching may be less than those from conventional mining, the impacts from an associated underground or open pit mine remain substantial. For these reasons, this alternative was deemed not suitable for the proposed project.

8.1.4 Satellite Facilities versus Central Processing Facility

Shipping uranium-laden resin is a standard industry practice for Satellite facilities in conjunction with central processing facilities. However, the option of processing and drying on site versus shipping resin for processing and drying to a CPP was eliminated for the following reasons:

- Environmental Health and Safety: A CPP will potentially create more 11e.(2) and non-11e.(2) wastes than a Satellite facility requiring more waste to be transported and disposed at a licensed facility; and
- Operating Cost: The costs associated with the construction and operations of a CPP outweigh the costs associated with that of a Satellite facility. Uranium One's Willow Creek CPP has the capacity for toll processing of resin which will make the construction of a CPP for the proposed Ludeman Project gratuitous.

8.1.5 Lixiviant Chemistry

Uranium One proposes to use a sodium bicarbonate lixiviant which is an alkaline solution. Where the groundwater contains carbonate, an alkaline lixiviant mobilizes fewer potentially deleterious constituents from the ore body and requires chemical addition than an acidic lixiviant. Also, test results at other, similar uranium ISR projects indicate only limited success with acidic lixiviants, while the sodium bicarbonate has proven highly successful at commercial ISR recovery operations in Wyoming to date. Another alternate leach solution is an ammonium carbonate solution which has been used in ISR programs at other locations; however, operators have experienced difficulty in restoring and stabilizing the aquifer. Therefore, these solutions were excluded from Uranium One consideration for the proposed project.

8.1.5.1 Acidic Leach Solutions

Acid-based lixiviants, such as sulfuric acid, have been used in the United States and are widely used internationally. Acid leach has historically produced a majority of the world's ISR production. Acid-based lixiviants generally achieve a higher degree of recovery (70-90%), better leaching kinetics, and a shorter leaching period. However, acid-based lixiviants dissolve heavy metals and other solids associated with uranium in the host rock and other chemical constituents that may required additional remediation (International Atomic Energy Agency, 2001).

In the United States, acid-based lixiviants have been used only for small-scale research and development operations. At the Nine Mile test site in Wyoming, test patterns were developed using acid-based and carbonate-based lixiviants. The acid-based pattern developed two significant problems. During uranium recovery operations, gypsum precipitated on well screens and within the aquifer, plugging wells and reducing the efficiency of wellfield circulation. Restoration efforts had limited success, apparently due to gradual dissolution of the precipitated gypsum following restoration, resulting in increased salinity and sulfate levels in the affected groundwater (Mudd, 2000).

The commercial use of alkaline lixiviants in the United States has been related to the need to restore affected groundwater and alkaline mine sites are recognized to be technically easier to restore. For this reason, a commercial ISR facility using an acid-based lixiviant has not been developed in the United States and Uranium One determined an acid-based lixiviant was not a suitable alternative for the proposed project.

8.1.5.2 Ammonia-based Lixiviants

Ammonia-based lixiviants have been used in the United States, in Texas and Wyoming. However, operational experience has shown ammonia tends to adsorb onto clay minerals

in the subsurface and then desorbs slowly from the clay during restoration, therefore requiring that a much larger volume of groundwater be removed and processed during aquifer restoration (Mudd, 2000). In addition, concerns arose in the early 1980s over the potential post mining oxidation of ammonia in the groundwater to form nitrate and nitrite species. When combined with the slow desorption from clay this potential difficulty resulted in a movement away from ammonia-based lixiviants including an outright ban on their use in Texas. Due to the additional consumptive use of groundwater to meet groundwater restoration requirements, Uranium One determined that an ammonia-based lixiviant is not a suitable alternative for the proposed project.

8.1.5.3 Other Potential Lixiviants

Other lixiviants which have been evaluated in laboratory scale and limited field tests include potassium based lixiviants, a range of oxidants including air, iodine, potassium permanganate, and a variety of trace additives such as clay stabilizing agents to increase the selective oxidation and mobilization of uranium minerals. To date, these alternatives have consistently proven to be far less economical than the planned oxygen-sodium bicarbonate system.

8.1.6 Groundwater Restoration

The groundwater restoration techniques proposed by Uranium One have been successful at other ISR operations in Wyoming. Groundwater sweep, permeate/reductant injection and groundwater treatment have successfully restored the groundwater to pre-mining quality or designated regulatory limit. No practicable alternative(s) to the groundwater restoration method noted herein currently is available. The NRC and the WDEQ consider the method currently employed as the Best Practicable Technology available.

8.1.7 Alternate Waste Management Options

Liquid wastes generated from production and restoration activities generally are managed at ISR facilities by solar evaporation ponds, deep well injection, land application or some combination thereof. The use of deep waste disposal well(s) is considered by Uranium One to be the best alternative to dispose of these types of wastes. The proposed project deep injection well(s) will isolate liquid wastes generated by the project from any underground source of drinking water (USDW). These wells must be authorized by the State of Wyoming under an appropriate Underground Injection Control (UIC) Permit.

Uranium One has considered a wide range of liquid treatment/disposal methods for use at the proposed project. The alternatives analysis considered three primary waste streams from ISR operation:

- Facility eluant;
- Wellfield purge water; and
- RO reject produced during wellfield restoration.

A "design basis influent" was developed for the three typical ISR wastewater streams to be managed as well as the projected water quality characterization for blending the waste streams. The alternatives analysis was completed stepwise with the development of a common evaluation basis, screening of potentially applicable treatment technologies, development of candidate treatment trains, and technical and cost evaluation of the treatment trains. The initial screening of treatment technologies included evaluation of each technology for implementability, flexibility, maintainability, and relative capital and operating costs. The retained technologies were developed into treatment options and then the comparative evaluation of each option was conducted in parallel for each waste stream. Both capital and annual operating costs were developed for each option in order to calculate a net present value. The costs developed were comparative order-of-magnitude estimates intended for comparison purposes and were based on an ISR model case that could then be scaled to a particular operation. Costs that were common to all options such as regulatory reporting, project management, and administrative costs were not included.

Land application is feasible and historically has been used at some ISR facilities as a wastewater treatment/disposal method, generally in conjunction with deep well disposal and/or spray/solar evaporation. Discharges through land application may have to be treated to meet surface water quality standards and soil concentration limits to assure that there is no potential for future environmental liability due to accumulation of contaminants in the soil or groundwater below the land application surface area. For this reason land application was not chosen in the screening process for further consideration.

The following discussion provides a description of each treatment/disposal method considered and the relevant characteristics that led to the selection of deep well injection as the preferred alternative.

8.1.7.1.1 Deep Well Disposal

On any site where geologic and hydrogeologic conditions will allow, deep well injection is the preferred method for wastewater disposal. Deep well injection is permitted primarily on the condition that potential Underground Sources of Drinking Water (USDW) cannot be adversely impacted by disposal operations, rather than by the quality and characteristics of the wastewater injected. NRC, however, requires characterization of the waste stream with respect to worker health and safety and analyses of potential consequences of leaks or spills. Accordingly, deep well "discharge standards" as

incorporated into a permit are based on the mine operator's characterization of the waste stream. This method was considered potentially suitable for all ISR waste streams.

8.1.7.1.2 Mechanical Evaporation

Mechanical evaporation utilizing equipment that requires either gas or electric power was considered. Evaporation is energy-intensive, but produces the smallest possible volume of waste for disposal. Disposal costs per unit volume can be evaluated against the evaporator operations cost to determine the economic viability of evaporation as a post-treatment step. For this evaluation it is assumed that a volume reduction of approximately 95% is achieved. This method was considered potentially suitable for all ISR waste streams.

8.1.7.1.3 Chemical Precipitation and Reverse Osmosis

Chemical precipitation and reverse osmosis which can utilize the chemical precipitation step to either pre-treat the wastewater for more efficient operation of the reverse osmosis system or use the chemical precipitation step to treat the brine was considered. Both brine residual and sludge are formed. This method was considered potentially suitable for all ISR waste streams.

8.1.7.1.4 Spray/Solar Evaporation

Spray/solar evaporation utilizing natural evaporation and enhancing the rate by spraying water to increase the surface area, which was assumed to provide a 95 percent volume reduction for this evaluation, was considered. While solar evaporation is technically feasible, the evaporation rate and length of the evaporation season must be considered in parallel with the flow rate of water to be treated. Evaporation pond size may become unreasonably large if the evaporation rate is low. If sprayers are used for evaporation enhancement, overspray due to high winds must be controlled. Additional issues with evaporation ponds include windblown accumulations of dust and dirt, and the eventual need to remove salts and accumulated solids. This method was considered unsuitable for ISR waste streams.

Table 8-1 provides a summary of the technical and cost evaluation of candidate water treatment and management options for a combination of the process wastewaters. For each of the alternatives considered, the table lists the advantages and disadvantages, the chemicals required, residues storage capacity, required offsite shipments, power requirements, labor requirements, environmental and safety considerations, capital cost, and 20year Net Present Value (NPV). For capital cost and 20 year NPV, the deep

disposal well alternative is considered the base case and the capital cost and 20 year NPV for the other alternatives are scaled from it.

As shown by Table 8-1, the NPV for the Deep Well Alternative and the Spray/Solar Evaporation Alternative were the most favorable (lowest estimated life cycle cost), with the Deep Well Option as the lowest overall cost. The Deep Well option presents additional environmental, safety and health benefits including the following:

- Minimize worker exposure to concentrated brine streams that may contain uranium and byproduct material;
- Minimize the required footprint and therefore land disturbed by the system;
- Minimize the residual, either solid or liquid, stored onsite and also shipped offsite. There is no offsite transportation of residual required with a deep well; and
- Minimize the requirement for chemicals and other commodities.

Based on this comparative evaluation the deep well water management alternative for ISR wastewater provides clear economic and environmental advantages. All solid wastes will be properly managed.

8.1.8 Uranium Processing Alternatives

8.1.8.1 Higgins Loop

In coordination with the NRC GEIS, Uranium One's Proposed Action includes the use of pressurized down-flow ion exchange system. With this ion exchange system the radon present in the barren recovery solution is forced back underground in the re-fortified groundwater which, thereby, provides for significantly reduced potential for occupational and/or public exposure to radon and its progeny of pressurized down-flow ion exchange columns.

An alternative considered by Uranium One was to utilize a Higgins Loop ion exchange system. The Higgins Loops is a closed-loop system in which uranium-laden resin advances through the system in the different stages of adsorption, backwash, regeneration, and rinse in preparation for another adsorption cycle. The ion exchange system is a vertical cylindrical loop, containing a packed bed of resin that is separated into four operating zones by butterfly, or "loop" valves. These operating zones, adsorption, regeneration, backwashing and pulsing function like four separate vessels thus increasing the resin loading efficiency.

The Higgins loop resin exchange process is disadvantageous as it results in significant attrition of the resin. The flow system used to load and strip the resin of uranium

generates a significant back pressure. The back pressure results in excessive compressive forces on the resin itself and results in damage to the resin particles. The damage resin particles will often increase the back pressure in the system, resulting in accelerated damage to the resin. Additionally, the cycling of the resin between the loading chamber and the stripping chamber results in damage to the resin as the resin particles experience significant physical impact with other resin particles, the chamber walls and plumbing, valves, etc. The damage to and loss of the resin results in significant additional costs for replacement resin. If it is determined that advances in resin and valve technologies negate the damage to the resin this process alternative may be re-evaluated and potentially implemented.

8.1.8.2 Central Processing Facility

At a Central Processing Facility ion exchange resin loaded with uranium is pumped into the elution (stripping) column. The resin is then treated with eluant (stripping solution) composed of water, salt (to add chloride) and soda ash (to maintain high pH and carbonate levels). The uranium on the resin is exchanged for the chloride ions in the stripping solution and is complexed by the carbonate. It is then precipitated from the stripping solution with hydrochloric acid and ammonia. The resulting uranium bearing slurry is washed, dewatered and dried

Uranium One will utilize the Willow Creek Central Processing Facility (SUA-1341) for further processing of uranium loaded resin produced from the proposed Ludeman Satellite facilities. The use of these Central Processing facilities led to the selection of Satellite facilities as the preferred alternative for the proposed Ludeman Project.

Table 8-1: Treatment Alternatives Comparative Evaluation Matrix – 150 gpm ISL Wastewater

Evaluation Factor	Deep Well	Mechanical Evaporation	Chemical Precipitation/RO	Spray/Solar Evaporation
Advantages	Economical, no residuals so no onsite storage or offsite transport required, no concentrated chemicals required, minimal operating requirements, minimal space requirements, flexible with regard to water quality and disposal rate.	Produces very low volume brine for disposal or further processing by solidification or to dry salt for zero liquid discharge, produces treated water with essentially zero contaminants (distilled water), can be operated campaign style.	Broadly applicable to metals and common anion contaminants, chemical precipitation pretreatment allows operation of RO system to produce less brine, produces high quality treated water stream for reuse or discharge.	Primary treatment is simple system consisting of ponds, pumps, piping and nozzles. No complicated equipment, low capital cost. Commonly used for management of brine in arid climates. Can allow complete evaporation to dryness or remove low volume brine for solidification and offsite disposal.
Disadvantages	Site geology will dictate feasible disposal flow rate. Site hydrogeology (presence of potential drinking water aquifers) will dictate disposal well depth. Permitting process may be lengthy. Attention to water chemistry and need for antiscalent is required to minimize wellscreen scaling and fouling issues. Changes in water chemistry may require re-permitting. No recovery of treated water.	Long equipment lead, distillate is corrosive and would need conditioning for reuse or discharge, high capital and power cost, concentrates radionuclides into the evaporator brine by 20 times or more.	Produces both liquid and solids residues with higher volume liquid residues that other options. Highest labor. Requires bulk concentrated chemicals. Highest truck traffic of options evaluated for chemical deliveries and residuals transport.	Treatment rate dependent upon weather. "Overdesign" required to account for weather shutdowns. Potential for birds and other wildlife to drink and contact water. Treatment time affected by wind with high potential for overspray. Reduced efficiency and operating difficulty due to freezing in winter so large storage capacity required. Windborne dust and dirt reduce efficiency and increase maintenance (cleanouts). Large quantities of chemicals required for solidification and large quantities of solidified brine produced for offsite disposal.
Chemicals Required	None to minimal. Antiscalent may be required depending on water characteristics.	Minimal for evaporator and limited to antiscalent compounds and some cleaning products. Lime, soda ash, and polymer required for solidification.	Lime Concentrated acid Polymer, antiscalent and RO cleaning chemicals. Lime, soda ash and polymer for solidification.	Lime, soda ash, and polymer for solidification.

Evaluation Factor	Deep Well	Mechanical Evaporation	Chemical Precipitation/RO	Spray/Solar Evaporation
Residues Storage Capacity	Small feed tank – 10,000 gal storing regular strength wastewater	60,000 gal brine storage – approximately 5 days of storage for feed to solidification system. 100 yd^3 solidified brine (3-4 days)	200,000 gal brine storage – (4 days) 80 yd^3 sludge (20% solids by weight) from chemical precipitation storage 500 yd^3 solidified brine (3-4 days)	40,000,000 gal storage for low evaporation months 60,000 gal brine storage for low evaporation months 100 yd^e solidified brine (3-4 days)
Offsite Shipments	None	Approximately 10 trucks per week with solidified brine.	Approximately 43 trucks per week with solidified brine and dewaterered sludge.	Approximately 10 trucks per week with solidified brine.
Other Considerations	None	Brine is concentrated waste (20X feed), potentially characterized as hazardous or mixed waste	Brine is concentrated waste (6X feed) potentially characterized as hazardous or mixed waste	Brine is concentrated waste (20X feed) potentially characterized as hazardous or mixed waste
Power	710,000 kwh/yr	11,008,000 kwh/yr	2,912,000 kwh/yr	8,822,000 kwh/yr
Labor	Minimal	3 – 4 FTE	6 FTE	3 – 4 FTE
Environmental /Safety	Safest and lowest environmental impact of options. Smallest carbon footprint with low operating power requirement and no truck traffic. No residuals stored onsite, no potential for wildlife exposure to holding ponds. No requirement for chemicals. No potential exposure to concentrated residues.	Large carbon footprint with over 10 times the power requirement of a deep well and 20 times the power requirement of the RO/precipitation option. Requires high operating temperatures and pressures. Low to moderate footprint primarily for brine storage tanks. Requires storage of brine as feed to solidification system and offsite transportation of solidified brine stream. High chemical requirements for solidification chemicals. High operating temperature and pressure.	Moderate carbon footprint with the lowest operating power requirement but the most truck traffic of any option evaluated. Handling of highest quantity of residues required including onsite storage and offsite disposal. Higher labor requirements with more potential for exposure to chemicals and residuals during sludge dewatering operations and residuals management.	Moderate carbon footprint with greater the power required of a deep well and some truck traffic for offsite brine disposal. Greatest risk to wildlife due to large volume ponds. Greatest potential for release of salts from overspray. Potential for exposure to labor from the sprays.
Capital Cost Estimate	Base Case	3.56 times base case	1.79 times base case	4.21 times base case
20 Year NPV	Base Case	17.6 times base case	68.9 times base case	17.9 times base case

8.2 COMPARISON OF THE PREDICTED ENVIRONMENTAL IMPACTS

As disucussed above, Uranium One has identified and developed the proposed action as the best approach to recovering uranium resources from the proposed project. Table 8-2 provides a summary of the potential environmental impacts for the no-action alternative (Section 8.1.1), the proposed action (Section 8.2), and the reasonable alternatives although deemed not suitable (Section 8.1.3). The predicted impacts for the Uranium One recovery alternatives discussed in this section are not included for comparison because these alternatives were eliminated due to potential significant environmental and economic impacts. Section 4 of the ER provides a more detailed discussion of potential environmental impacts of the proposed action and no-action alternatives.

Table 8-2: Comparison of Predicted Environmental Impacts

Potential Impact	Alternative	Potential Impacts
Potential Land Surface Impacts	Proposed Action	Surface disturbance will range from short term for construction of well pads and utility corridors that will be reclaimed after construction to long term for roads, buildings, parking areas, and surge ponds that will remain until final D&D. All disturbance will be reclaimed to be suitable for pre-construction uses.
	No Action	None
	Conventional Mining/Milling Including Heap Leach	Open-pit mining would result in significant surface disturbance due to the pit overburden stockpiling and would create permanent topographic changes, increase fugitive dust, and the potential for subsidence. Both heap leaching and open-pit mining methods require crushing the ore and disposing of the tailings, creating long term or permanent 11e. (2) byproduct material.
	CPP versus Satellite Facility	Satellite facility would result in a smaller surface disturbance due the smaller facility size than the proposed central processing facility.
	Use of Alternate Lixiviants	Same as Proposed Action
	Alternate Waste Management	Disposal in evaporation ponds would result in slightly more surface disturbance than the proposed surge ponds due to the increased surface area to aid in the evaporation process.
	Uranium Processing Alternatives	Same as the Proposed Action

Table 8-2: Comparison of Predicted Environmental Impacts (Continued)

Potential Impact	Alternative	Potential Impacts
Potential Land Use Impacts	Proposed Action	Small impacts on agricultural production (livestock grazing) and hunting on up to eight acres for duration of the proposed project.
	No Action	None
	Conventional Mining/Milling Including Heap Leach	Area used for pit, ramps, haul roads, overburden stockpiles, and topsoil stockpiles would be restricted from any other uses for the duration of the proposed project.
	CPP versus Satellite Facility	Same as Proposed Action
	Use of Alternate Lixiviants	Same as Proposed Action
	Alternate Waste Management	Same as Proposed Action plus additional land use impact from installation of evaporation ponds and/or land application areas.
	Uranium Processing Alternatives	Same as Proposed Action

Table 8-2: Comparison of Predicted Environmental Impacts (Continued)

Potential Impact	Alternative	Potential Impacts
Potential Transportation Impacts	Proposed Action	Approximately eight acres will be disturbed to construct infrastructure access roads. A small risk of spills of process chemicals and small quantities of 11e. (2) byproduct material during the project life.
	No Action	None
	Conventional Mining/Milling Including Heap Leach	Conventional mining methods would require more employees which will increase traffic on local roads.
	CPP versus Satellite Facility	A Satellite facility would increase the traffic volume due to the shipment of loaded resin to a central processing facility
	Use of Alternate Lixiviants	Same as Proposed Action
	Alternate Waste Management	Same as Proposed Action
	Uranium Processing Alternatives	Same as Proposed Action

Table 8-2: Comparison of Predicted Environmental Impacts (Continued)

Potential Impact	Alternative	Potential Impacts
Potential Geology and Soil Impacts	Proposed Action	No significant impacts on geology. Approximately eight acres will be stripped of topsoil for construction of facilities. Topsoil will be stockpiled and seeded with a temporary seed mix to protect from erosion until it is replaced during reclamation. Once replaced the soil will be revegetated and support pre-construction land use.
	No Action	None
	Conventional Mining/Milling Including Heap Leach	Open pit mining would have significant impacts on geology and soil since all overburden from the surface to the ore zones would be removed. The overburden would be stockpiled and seeded with a temporary seed mix to protect form erosion until replaced during reclamation.
	CPP versus Satellite Facility	Same as the Proposed Action
	Use of Alternate Lixiviants	Same as the Proposed Action
	Alternate Waste Management	Evaporation ponds were require a larger surface area disturbance than the Proposed Action resulting in more topsoil removal and stockpiling.
	Uranium Processing Alternatives	Same as the Proposed Action

Table 8-2: Comparison of Predicted Environmental Impacts (Continued)

Potential Impact	Alternative	Potential Impacts
Potential Surface Water Impacts	Proposed Action	Surface disturbance may pose a small risk of increased sediment load to ephemeral drainages. Minimal risk of fuel or chemical spills.
	No Action	None
	Alternate Milling Method	Open pit mining would alter the surface drainage network requiring the restoration of all drainages during reclamation. The surface disturbance is significantly increased from the proposed action and would pose a larger risk of sediment load to surface waters. In addition, the potential for large amounts of groundwater to be discharged from the open pit would impact ephemeral drainages that only see flow during runoff or storm events.
	CPP versus Satellite Facility	Same as the Proposed Action
	Use of Alternate Lixiviants	The potential spill of an acid or ammonia based lixiviant would have more of an adverse effect on surface water than a sodium-bicarbonate based lixiviant.
	Alternate Waste Management	Evaporation ponds would disturb more surface area resulting in the increased risk of sediment load to drainages.
	Uranium Processing Alternatives	Same as the Proposed Action

Table 8-2: Comparison of Predicted Environmental Impacts (Continued)

Potential Impact	Alternative	Potential Impacts
Potential Groundwater Impacts	Proposed Action	Excursion of lixiviant may have a small potential to contaminate adjacent aquifers. Minimal risk of fuel or chemical spills leaching to shallow aquifer. Small net withdrawal of water from the ore zone aquifer to contain fluids. Water consumed will naturally recharge with time.
	No Action	None
	Alternate Milling Method	Open-pit and underground mining would drastically alter the hydrogeology of the area. All aquifers from the bottom of the ore zone to the surface would be exposed. Groundwater exposed in pit would need to be discharged altering surface water flow.
	CPP versus Satellite Facility	Same as the Proposed Action
	Use of Alternate Lixiviants	The potential migration of an acid or ammonia based lixiviant would have more of an adverse effect on groundwater than a sodium-bicarbonate based lixiviant.
	Alternate Waste Management	Same as the Proposed Action
	Uranium Processing Alternatives	Same as the Proposed Action

Table 8-2: Comparison of Predicted Environmental Impacts (Continued)

Potential Impact	Alternative	Potential Impacts
Potential Ecological Impacts	Proposed Action	BMPs will minimize wildlife access to lined retention ponds and storage facilities. No threatened or endangered species will be impacted. Loss of habitat will be minimal and temporary.
	No Action	None
	Alternate Milling Method	Open pit mining would disturb much more habitat by increased surface disturbance.
	CPP versus Satellite Facility	Same as the Proposed Action
	Use of Alternate Lixiviants	Same as the Proposed Action
	Alternate Waste Management	More habitat loss could result due to increased impoundment size.
	Uranium Processing Alternatives	Same as the Proposed Action

Table 8-2: Comparison of Predicted Environmental Impacts (Continued)

Potential Impact	Alternative	Potential Impacts
Potential Air Quality Impacts	Proposed Action	Slight increases in fugitive dust will occur, primarily during construction. An increase in fugitive dusts over baseline levels will occur during the life of the project. Combustion and greenhouse gases will be minimal and offset by the recovered uranium.
	No Action	None
	Alternate Milling Method	Open-pit mining would increase fugitive dust emissions by exposing much more disturbed soil surface. Large equipment would increase gaseous greenhouse emissions. Tailings would increase risk of airborne contaminants, including radioactive materials.
	CPP versus Satellite Facility	The potential for impact to air quality increases with a CPP due to the potential exposure to dried yellowcake particulates from an accident.
	Use of Alternate Lixiviants	Same as Proposed Action, possibly for an extended amount of time if alternate lixiviant requires more time for restoration.
	Alternate Waste Management	Increased emissions may occur if larger lined retention ponds are constructed.
	Uranium Processing Alternatives	Same as Proposed Action

Table 8-2: Comparison of Predicted Environmental Impacts (Continued)

Potential Impact	Alternative	Potential Impacts
Potential Noise Impacts	Proposed Action	Noise will increase over background levels. Nearest residence could experience noise levels above the annoyance (55-dBA) threshold during construction.
	No Action	None
	Alternate Milling Method	Increased noise levels would result from open-pit mining due to heavy equipment operation.
	CPP versus Satellite Facility	A CPP would potentially produce less noise with the absence of resin shipping trucks.
	Use of Alternate Lixiviants	Same as Proposed Action, possibly for an extended amount of time if alternate lixiviant requires more time for restoration.
	Alternate Waste Management	Same as Proposed Action
	Uranium Processing Alternatives	Same as Proposed Action

Table 8-2: Comparison of Predicted Environmental Impacts (Continued)

Potential Impact	Alternative	Potential Impacts
Potential Historical and Cultural Impacts	Proposed Action	Potential impacts will be minimal, since NRHP eligible sites do not exist on the proposed project site. A stop-work provision will be used if any previously undiscovered cultural resources are found.
	No Action	None
	Alternate Milling Method	Open-pit mining disturbs more area than that of ISR facilities increasing the chance of disturbing unknown cultural resources.
	CPP versus Satellite Facility	Same as Proposed Action
	Use of Alternate Lixiviants	Same as Proposed Action
	Alternate Waste Management	Similar to Proposed Action, although potential impacts could increase with increased retention pond size.
	Uranium Processing Alternatives	Same as Proposed Action

Table 8-2: Comparison of Predicted Environmental Impacts (Continued)

Potential Impact	Alternative	Potential Impacts
Potential Visual/Scenic Impacts	Proposed Action	Minimal visual impacts will result from new structures and equipment but will remain consistent with the BLM visual resource classification of the area.
	No Action	None
	Alternate Milling Method	Open-pit mining would create a significant visual impact with large stockpiles and a large tailings impoundment.
	CPP versus Satellite Facility	Similar to the Proposed Action
	Use of Alternate Lixiviants	Same as Proposed Action, possibly for an extended amount of time if alternate lixiviant requires more time for restoration.
	Alternate Waste Management	More and larger impoundments than required under the Proposed Action would have localized visual impacts.
	Uranium Processing Alternatives	Same as Proposed Action

Table 8-2: Comparison of Predicted Environmental Impacts (Continued)

Potential Impact	Alternative	Potential Impacts
Potential Socioeconomic Impacts	Proposed Action	Most of the workforce is expected to come from the local area minimizing impacts on housing and local services. Project would have slight, positive benefit to the State on severance tax, royalty, and sales and use tax collections and moderate benefits to Campbell County on property and production taxes. Remoteness of the site might slightly increase the need for increased emergency services (fire and ambulance service).
	No Action	None
	Alternate Milling Method	Conventional mining and milling methods require more employees than ISR facilities. Revenues to the State, which are based on production, would be similar to Proposed Action, but Campbell County revenues from property taxes would be more due to additional equipment required for conventional mining.
	CPP versus Satellite Facility	A CPP would require more employees than a Satellite facility which would have a direct positive impact on the local economy
	Use of Alternate Lixiviants	Same as Proposed Action, possibly for an extended amount of time if alternate lixiviant requires more time for restoration.
	Alternate Waste Management	Same as Proposed Action possibly extending the construction period due to the need to construct more impoundments.
	Uranium Processing Alternatives	Same as Proposed Action

Table 8-2: Comparison of Predicted Environmental Impacts (Continued)

Potential Impact	Alternative	Potential Impacts
Potential Non-Radiological Impacts	Proposed Action	Minimal risk of public exposure through chemical leaks and spills will be mitigated by employing BMPs.
	No Action	None
	Alternate Milling Method	Conventional mining and milling methods have an increased risk and more severe accidents compared to that of the Proposed Action. Safety hazards are compounded due to the depths of the mineral ore to be recovered.
	CPP versus Satellite Facility	A CPP has additional equipment and chemicals that could present safety hazards not found in a Satellite facility
	Use of Alternate Lixiviants	Similar to Proposed Action; acid or ammonia-based lixiviant would introduce additional non-radiological health risks.
	Alternate Waste Management	Same as Proposed Action
	Uranium Processing Alternatives	Same as Proposed Action

Table 8-2: Comparison of Predicted Environmental Impacts (Continued)

Potential Impact	Alternative	Potential Impacts
Potential Radiological Impacts	Proposed Action	The estimated radiological impacts resulting from routine site activities will be compared to applicable public dose limits as well as naturally occurring background levels.
	No Action	None
	Alternate Milling Method	Radiological exposure to the personnel in these processes is increased, not only from the mining process but also from milling and the resultant mill tailings. The milling process generates a significant amount of waste relative to the amount of ore processed. Extensive mill tailings impoundments are needed for the disposal of these wastes.
	CPP versus Satellite Facility	Same as Proposed Action
	Use of Alternate Lixiviants	Same as Proposed Action
	Alternate Waste Management	Same as Proposed Action
	Uranium Processing Alternatives	Same as Proposed Action

Table 8-2: Comparison of Predicted Environmental Impacts (Continued)

Potential Impact	Alternative	Potential Impacts
Potential Waste Management Impacts	Proposed Action	The proposed project deep injection well(s) will isolate liquid wastes generated by the project from any underground source of drinking water. A slight risk of exposure to the public during transportation exists though will be minimized by employing BMPs.
	No Action	None
	Alternate Milling Method	Conventional mining and milling creates considerably more waste than ISR, including tailings, which would be 11e.(2) byproduct material, and residue left from the treatment of water.
	CPP versus Satellite Facility	A CPP will potentially create more 11e.(2) and non-11e.(2) wastes than a Satellite facility requiring more waste to be transported and disposed at a licensed facility.
	Use of Alternate Lixiviants	Same as Proposed Action
	Alternate Waste Management	Evaporation ponds accumulate salts and windblown material such as dust that will need eventual removal increasing the risk for potential impacts during transport to an off-site facility.
	Uranium Processing Alternatives	Same as Proposed Action

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9 BENEFIT-COST ANALYSIS

9.1 BENEFIT-COST ANALYSIS GENERAL BACKGROUND

Demand for uranium to fuel nuclear power facilities is set to grow rapidly as the nuclear industry expands. The world's appetite for energy is expanding at a fast pace, driven largely by modernization of the developing nations. At the same time as total energy demand is growing, there is a growing impetus to reduce the burning of carbon-based fuels. Currently, nuclear energy provides 6 percent of the world's total energy supply, including 15 percent of the world's electricity. Some countries rely heavily on the nuclear industry. In the United States nearly 20 percent of the electricity is produced from nuclear power compared to France where it is 78 percent (U.S. Energy Information Administration 2010a).

The general need for production of uranium is assumed in the operation of nuclear power reactors. In reactor licensing evaluations, the benefits of the energy produced are weighed against environmental costs, including a prorated share of the environmental costs of the uranium fuel cycle. This section summarizes costs and benefits of the proposed development of the proposed project. The Benefit-Cost Analysis (BCA) discussed in this section has established that the proposed development of a new uranium ISR facility at the proposed project is potentially a cost-effective effort to undertake and will provide a net economic benefit to the State of Wyoming.

The analysis described in this section has been tailored to meet the requirements established by the NRC NUREG-1569 (Section 9). It includes a description of economic costs and benefits resulting from construction, operation, restoration, reclamation, and decommissioning of the proposed facility and a discussion of temporary and long-term external costs. Where possible, benefit and cost estimates are monetized; however, reliable monetary estimates for some potential impacts are not readily available so the narrative examines several factors in non-monetary or qualitative terms.

The following analyses use IMPLAN (IMpact Analysis for PLANning), a standard industry software package that models the economic impacts of capital intensive projects, to calculate the potential economic impacts to the county. Results derived from IMPLAN software have been approved in applications for Uranium One's Moore Ranch facility (Uranium One USA, Inc. SUA-1596). IMPLAN was originally developed by the United States Department of Agriculture (USDA) in cooperation with the Federal Emergency Management Agency (FEMA) and the United States Department of the Interior (USDI) Bureau of Land Management (BLM) for land and resource management planning (IMPLAN 2004). Currently, it is being managed by the Minnesota IMPLAN Group, Inc. (MIG).

9.2 ALTERNATIVES AND ASSUMPTIONS

BCA is a widely used analytical tool to help decision makers determine whether the cost of a project today will result in sufficient benefits to justify expenditure on a capital intensive project (Brown 2003; Zerbe and Bellas 2006). To provide value and to assist in the decision process, the BCA needs to be clear about the alternatives being considered and the underlying assumptions including quantities of goods, labor costs, market conditions and discount rates used to compute net present value. The following discussion briefly identifies alternatives and key assumptions used throughout the analysis.

9.2.1 Development Alternatives

This BCA evaluates the benefits and costs of building the proposed project and all the costs and benefits resulting from its ongoing operation in Converse County, Wyoming. The BCA tradeoff under consideration involves comparing a future assuming the proposed project to a future that assumes the No Action Alternative.

9.2.1.1 No Action Alternative

Under the No Action Alternative, there would be no change in current land cover or land and water uses at the site; therefore, there would be no change in the existing underlying socioeconomic and demographic trends.

9.2.1.2 Proposed Action

The Proposed Action involves the construction and operation of a uranium ISR facility. The ISR technology involves leaving the ore where it is below the ground surface and pumping native ground water fortified with oxygen and carbon dioxide to recover the minerals from the ore. Consequently, the Proposed Action involves limited surface disturbance, no open mine pits, and no tailings or waste rock would be generated.

9.2.2 Key Assumptions and Limitations

Key assumptions about the costs and benefits associated with the proposed project involve: (1) The Operating Life of the project; (2) the Discount Rate used; (3) the potential Scope of the Monetary Impacts; and (4) Potential Non-monetary Impacts. Each of these is described in more detail below.

9.2.2.1 Operating Life of Project

For purposes of cost-benefit analysis, the proposed project includes wellfields, Satellite facilites, and outlying related structures. The total effective life of the project, based on initial calculations, is 13 years. This includes construction of Satellite facilities and wellfield infrastructure, operations, wellfield restoration, and Satellite plant decommissioning. The first year includes only construction costs, since operations will be limited to preparation work only during that first year. Decommissioning the last Satellite plant in the 13th year is the final phase. No operations staff or other operations costs were included in the analysis for that year. Those operations costs are, however, assumed to be minor compared to other years of construction and operation.

A total of seven wellfields and three Satellite facilities are projected over the life of the project. Figure 9-1 shows the projected schedule of construction, operations, and decommissioning for wellfields and Satellite facilities. Wellfield decommissioning is included in the Satellite plant decommissioning phase. As Figure 9-1 shows, in a single year there may be multiple construction, operation, and decommissioning activities.

It is possible that the proposed project life-span could be shorter than or exceed the projected 13 year period. This will depend on the amount of ore, recoverability of the ore, and market demand, among other factors.

9.2.2.2 Discount Rate

Computing the net present value (NPV) of the proposed project requires that future benefits and costs be discounted. This discounting reflects assumption that the time value of money reflected in benefits and costs is worth more if expected sooner. Following guidelines established by circular A-94 from the United States Office of Management and Budget (OMB), net present value estimates of benefits and costs are reported using a real discount rate of seven percent (OMB 2011). Circular A-94 was revised in 2011 based on extensive review and public comment and currently reflects the best available guidance on standardized measures of costs and benefits. This rate approximates the marginal pretax rate of return on an average investment in the private sector in recent years.

9.2.2.3 Scope of Impact

A critical step in any BCA is establishing a viable scope of potential impacts and thus establishing who or what will be affected by the proposed project (Zerbe and Bellas 2006). As a practical matter the proposed project will be limited to the potential impacts it may have on Converse and Natrona County.

9.2.2.4 Potential Non-monetary Impacts and Benefit-Cost Ratio

Conventional BCA uses monetary values to compare goods and services derived from a project or program. The values of goods and services represent their relative importance so that if the total value of the benefits is greater than the total value of the costs, the proposed project is desirable. The standard result is a quantified benefit-cost ratio (BCR), equal to a project's total net benefits divided by its total cost. BCR's above one have positive net economic impacts. While many inputs in the proposed project BCR are goods and services (skilled labor, construction material) that are regularly traded in markets at well known and predictable prices, others (changes to land or water, aesthetic impacts) are not directly traded and are more difficult to value. Where reliable monetary values are not available a qualitative approach based on the best available information is required.

9.3 ECONOMIC BENEFITS OF PROJECT CONSTRUCTION AND OPERATION

This section considers the potential economic impacts resulting from construction and operation-related activities over the life of the proposed project. For this analysis, economic impacts are measured by number of jobs and state and local tax revenues generated from the project.

The economic analyses were derived using IMPLAN (IMpact Analysis for PLANning) software and databases. IMPLAN was originally developed by the USDA Forest Service in cooperation with the Federal Emergency Management Agency and the USDI Bureau of Land Management to assist the Forest Service in land and resource management planning. The IMPLAN system has been in use since 1979. In 1993, Minnesota IMPLAN Group, Inc was formed to privatize the data and software.

IMPLAN allows the user to build an input-output model tailored to predict the potential impact of a proposed project on a specific community or region. The IMPLAN system is flexible and contains a database of over 500 economic sectors linked to the North American Industrial Classification System (NAICS). The NAICS is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. Using inputs such as labor, costs, or value of product for a particular IMPLAN sector, a user can project outputs of direct, indirect, and induced employment, generated tax revenues, and value.

The outputs are general estimates, based on a variety of parameters and multipliers built into the IMPLAN software and data. Actual economic effects may vary for a variety of

reasons. The following analysis is intended to provide only a general estimate for purposes of comparing the No Action Alternative with the Proposed Action Alternative.

9.3.1 IMPLAN Input Data

Wyoming was selected as the study area for IMPLAN impact analysis for a number of reasons. Although the project is located in Converse County, using only the county as the economic study area would result in an understatement of the overall economic impact of the project. This is because Converse County, with an estimated population of slightly less than 13,000 is too small for economic impact analysis purposes. The proposed project operator will necessarily look outside of the county for some of the goods and services needed to construct and operate the facility. Using the state of Wyoming (with an estimated population of 523,000 and with several larger retail/business communities such as Casper, Gillette, and Cheyenne) provides a greater likelihood that more of the goods and services needed for the project will come from the economic study area.

For economic analysis purposes, the proposed project is considered as two distinct components: 1) operations, and 2) construction and decommissioning. Operations include operation of the Satellite facilities and wellfields and wellfield restoration. It was assumed that decommissioning would involve similar parameters to construction.

IMPLAN calculations were based on costs and numbers of employees directly employed by the proposed project. The schedule, cost estimates, and direct employment and payroll information prepared by Uranium One were used as the economic analysis inputs. (Refer to Figures 9-1 through 9-4.)

Economic effects of operations were calculated using IMPLAN sector 24 (gold, silver or other metal ore mining). There is no separate IMPLAN sector for uranium facilities. The NAICS code for uranium-related industries (2212291) is included in IMPLAN Sector 24. The IMPLAN data for Wyoming for Sector 24 was modified for the proposed project analysis to better correspond to the project parameters as follows. The Wyoming state data included proprietary income as part of "Per Worker Earnings" for Sector 24. Since proprietor income inflated per worker earnings in Sector 24 compared to payroll cost projections prepared by Uranium One, it was zeroed from the equation. This adjustment then brought the per worker earnings into better alignment with the proposed project payroll cost estimates. Once this adjustment was made, the number of direct employees (for operations only) was used as the input to the IMPLAN model to predict the economic outputs of operating wellfields and Satellite facilities and restoring wellfields.

Economic effects of construction and decommissioning were calculated using two IMPLAN sectors: Sector 36 (construct other non-residential structures) and Sector 205 (construction machinery manufacturing). These sectors were arrived at by examining

U.S. Bureau of Economic Analysis Capital Flow data. The Capital Flow data indicate that approximately 44 percent of metal mining commodity expenditures are spent on construction activities, 30 percent on equipment and machinery, and 15 percent on transportation equipment (e.g., vehicles). The remaining 11 percent is spread among a number of categories in small amounts. IMPLAN's Regional Purchase Coefficient (RPC) for sector 36 in Wyoming is 100 percent. RPC represents the proportion of goods and services purchased from local producers. IMPLAN's RPC for sector 205 (construction machinery manufacturing) was 2.6 percent, meaning that although a high percentage of machinery and equipment may be purchased in Wyoming, only 2.6 percent of the total amount would be spent on construction machinery and equipment produced in Wyoming and the other 97.3 percent of expenditures would go to equipment and machinery manufacturing firms outside of Wyoming. There was no comparable category for transportation equipment in the IMPLAN sectors for Wyoming—vehicle manufacturing occurs in other states.

To arrive at estimated impacts, 44 percent of the total costs of construction (payroll and non-payroll costs) was applied to sector 36 (construction) and 30 percent of the total was applied to sector 205 (construction machinery) using the RPC of 2.6 percent. Much of the balance of 26 percent is assumed to be "leakage" from the state of Wyoming—costs going to goods produced elsewhere, such as vehicles. Still, the overall economic impacts of construction for this project are likely to be a conservative estimate, since some of the other goods and services that will be needed may be produced in Wyoming.

9.3.2 Employment Benefits

Using the above inputs and assumption, Table 9-1 summarizes the potential employment-related effects that could be generated by the proposed project. Table 9-1 shows the potential direct, indirect, and induced effects on state-wide employment. Employment is expressed as numbers of jobs. IMPLAN, like the Regional Economic Information System (REIS) of the US Bureau of Economic Analysis (BEA), measures an industry's employment as the average annual full and part-time number of employees. These numbers are estimates only. Actual numbers may vary based on a number of factors.

The direct employment effects refer to the employment directly generated by the project. These jobs would primarily be on the project site in Converse County. Estimated direct jobs per year peak in the fifth year of the project (in Year 2017) with approximately 96 jobs. Direct jobs include payroll positions with proposed project as well as persons employed through contract on construction and decommissioning.

Indirect employment includes jobs resulting from increased demand for products or goods related to the direct effects of construction, operations, and decommissioning. Indirect employment would include jobs such as those needed to support the direct

activities on site such as vehicle repair. Estimated indirect jobs peak at approximately 37 in the seventh year of the project (in 2019).

Induced employment is the result of expenditures caused by new household income generated by the direct and indirect effects. Food and beverage establishments, medical facilities, and retail businesses might likely require more employees to serve new residents or households with expanded incomes resulting from the increases in direct and indirect employment. Estimated induced jobs peak at approximately 36 in the seventh year of the project (in 2019).

Total potential direct, indirect, and induced employment figures fluctuates from year to year because each year there is a different combination of construction, operations, and decommission activities. At peak total employment in 2017, the project will provide approximately 164 total direct, indirect, and induced jobs..

Table 9-1: Employment Effects of the Proposed Project

	Direct	Indirect	Induced	Total
Year 2013 - Construction	65.4	16.2	17.3	98.9
Year 2013 - Operations	0.0	0.0	0.0	0
Subtotal	**65.4**	**16.2**	**17.3**	**98.9**
Year 2014 - Construction	37.9	9.4	10.0	57.3
Year 2014 - Operations	14.0	7.8	7.4	29.2
Subtotal	**51.9**	**17.2**	**17.4**	**86.5**
Year 2015 - Construction	65.4	16.2	17.3	98.9
Year 2015 - Operations	17.0	9.5	9.0	35.5
Subtotal	**82.4**	**25.7**	**26.3**	**134.4**
Year 2016 - Construction	37.9	9.4	10.0	57.3
Year 2016 - Operations	27.0	15.0	14.3	56.3
Subtotal	**64.9**	**24.4**	**24.3**	**113.6**
Year 2017 - Construction	65.4	16.2	17.3	98.9
Year 2017 - Operations	31.0	17.3	16.5	64.8
Subtotal	**96.4**	**33.5**	**33.8**	**163.7**
Year 2018 - Construction	37.9	9.4	10.0	57.3
Year 2018 - Operations	44.0	24.5	23.4	91.9
Subtotal	**81.9**	**33.9**	**33.4**	**149.2**
Year 2019 – Construction	40.4	10.0	10.7	61.1
Year 2019 - Operations	48.0	26.7	25.5	100.2
Subtotal	**88.4**	**36.7**	**36.2**	**161.3**
Year 2020 - Construction	0.0	0.0	0.0	0.0
Year 2020 - Operations	48.0	26.7	25.5	100.2
Subtotal	**48.0**	**26.7**	**25.5**	**100.2**
Year 2021 - Construction	0.0	0.0	0.0	0.0
Year 2021 - Operations	35.0	19.5	18.6	73.1
Subtotal	**35.0**	**19.5**	**18.6**	**73.1**
Year 2022 - Construction/Decommission	24.7	6.1	6.5	37.3
Year 2022 - Operations	34.0	18.9	18.0	70.9
Subtotal	**58.7**	**25.0**	**24.5**	**108.2**
Year 2023 - Construction/Decommission	0.0	0.0	0.0	0.0
Year 2023 - Operations	18.0	10.0	9.6	37.6
Subtotal	**18.0**	**10.0**	**9.6**	**37.6**
Year 2024 - Construction/Decommission	24.7	6.1	6.5	37.3
Year 2024 - Operations	17.0	9.5	9.0	35.5
Subtotal	**41.7**	**15.6**	**15.5**	**72.8**
Year 2025 - Construction/Decommission	0	0	0	0.0
Year 2025 - Operations	1	0.6	0.5	2.1
Subtotal	**1.0**	**0.6**	**0.5**	**2.1**
Year 2026 - Construction/Decommission	24.7	6.1	6.5	37.3
Year 2026- Operations	0	0	0	0.0
Subtotal	**24.7**	**6.1**	**6.5**	**37.3**

9.3.3 State and Local Tax Revenue Benefits

In addition to employment effects, IMPLAN models can provide general estimates of expected tax revenues. In order to remain consistent with the scope of impact, federal taxes are not included in this analysis. Tax revenue projections are estimates only. Actual numbers may vary based on a number of factors.

Potential state and local tax revenues associated with the proposed project are presented in Table 9-2. While IMPLAN models produce information on expected tax revenues from employee compensation (e.g., social insurance tax) and induced household expenditures (e.g., personal income tax, personal property tax and personal motor vehicle license tax), these tax revenues are not reported here because they represent a transfer of wealth rather than a net economic gain. Conversely, corporate dividend taxes and taxes included in the indirect business tax category are paid by businesses. Indirect business taxes consist of excise taxes, property taxes, fees, licenses, and sales taxes paid by businesses, but do not include taxes on profit or income. The indirect business taxes in Table 9-2 include all the direct, indirect, and induced effects.

Because all monetary inputs into the IMPLAN model were in constant 2009 dollars (regardless of the year in the overall project schedule) adjusted by the IMPLAN software program to constant 2007 dollars, no discount rate was applied to the results, which are also expressed in 2007 dollars.

Table 9-2: State and Local Tax Revenue (IMPLAN Projections expressed in 2007 dollar equivalents

	Enterprise Tax		Indirect Business Tax		
Year	Construction-Decommissioning	Operations	Construction-Decommissioning	Operations	TOTAL
2013	16,384	0	234,978	0	251,362
2014	9,486	102,706	136,023	638,543	886,758
2015	16,384	124,715	234,948	775,373	1,151,420
2016	9,486	198,076	136,023	1,231,475	1,575,060
2017	16,384	227,421	234,948	1,413,916	1,892,669
2018	9,486	322,791	136,023	2,006,848	2,475,148
2019	10,126	352,135	145,209	2,189,289	2,696,759
2020	0	352,135	0	2,189,289	2,541,424
2021	0	352,135	0	2,189,289	2,541,424
2022	6,193	249,429	88,814	1,550,746	1,895,182
2023	0	132,051	0	820,983	953,034
2024	6,193	124,715	88,814	775,373	995,095
2025	0	7,336	0	45,610	52,946
2026	6,193	0	88,814	0	95,007
Totals	106,315	2,545,645	1,524,594	15,826,734	20,003,288

During the estimated 13 years of the proposed project, annual state and local tax revenues are estimated to range from $53,000 to $2.7 million. Over the estimated 13-year project, total taxes are estimated at $20 million.

9.4 EXTERNAL COSTS OF PROJECT CONSTRUCTION AND OPERATION

In this section of the analysis, external costs of the proposed project are identified and compared to the no action alternative. Both short-term and long-term external costs that may affect the interest of people other than the owners and operators of the proposed project are also identified and described.

9.4.1 Short Term External Costs

9.4.1.1 Housing Shortages

At its peak levels of employment, the proposed project is estimated to produce approximately 164 total jobs in Wyoming. This includes jobs created directly or indirectly by the project or induced by related household expenditures. Many of the jobs will be ongoing over the life of the project (such as the number of persons directly employed by the operator or its contractors for ongoing operations and wellfield and Satellite construction). Others will be tied to specific phases, such as construction or decommissioning, and will be shorter-term rather than on-going. As a result, the total number of jobs is estimated to fluctuate from year to year.

Compared to the rest of the nation, unemployment rates are low in Converse and Natrona Counties, the area most likely to be affected by the increased number of jobs and associated housing demand. These counties are however beginning to feel the effects of the national recession. In June 2009, the unemployment rate in Converse County was 5.2 percent (compared to 2.8 percent in June 2008) and 6.1 percent in Natrona County (compared to 3.0 percent in June 2008). In June 2009, the national unemployment rate was 9.5 percent. The average unemployment rate between July 2008 and June 2009 was 7.6 percent in the nation, but it remained below 4 percent in Converse and Natrona Counties. It is anticipated that Converse and Natrona Counties will continue to have lower unemployment rates than the state and the nation. In part, due to the relatively lower unemployment in the local area and the small population base, it is assumed that the supply of available workers is limited locally and that many (and possibly most) of the employees needed to fill the projected new local jobs will come from outside Converse and Natrona Counties.

At the peak of direct employment numbers (in 2017), the proposed project would account for approximately 96 new jobs. Assuming each new job resulted in a separate demand for

housing, 96 housing units would be needed. Homeowner vacancy rates were 2.3 percent in Converse County and 1.5 percent in Natrona County; according to the 2000 Census (the most recent for which such census data are available at the county level). In a multiple listing service (MLS) internet web search on March 26, 2009, there were 420 listings for houses priced at $300,000 or less in Glenrock (27), Douglas (36), and Casper (357). In July 2007, Converse County had an estimated two vacant units out of 424 total rental units (.47 percent rental vacancy rate) and Natrona County had 44 vacant rental units (1.07 percent rental vacancy rate). The lack of available rental units in Converse County was reported in the Douglas Budget on November 26, 2008. Many people who desire rental units have been staying in hotels/motels for weeks and months at a time.

Based on these data, there would be adequate supply of houses available for sale for needs associated with direct employment from the proposed project and a very limited supply of rental units. It is assumed that the supply of houses for sale that are in good "move-in" condition and in desirable areas may be less than the total number of houses for sale, but with more than 400 available (as of March 2009), there would be sufficient numbers for the estimated 96 new homes needed for direct employment numbers. Some of the employees will likely be hired from the existing local labor pool and therefore 96 homes may overestimate housing demand from direct employment. Based on current trends, it is anticipated that at least some workers will continue to have a residence outside of Converse and Natrona Counties and will be commuting long distance for shift work. While on site, many of these workers would likely be staying in rentals or hotels/motels, based on historical trends. Unless additional rental units are created, this will exacerbate the existing tight rental market.

The total of all new direct, indirect, and induced jobs estimated by the IMPLAN analysis are for the state of Wyoming, not just Converse and Natrona Counties. If all 164 new direct, indirect, and induced jobs (at the peak of total employment in 2017) were in Converse and Natrona Counties, there would be adequate housing stock to purchase (based on the March 2009 homes for sale), but rental housing would be inadequate and put additional strains on hotels and motels.

9.4.1.2 Impacts on Schools and Other Public Services

The estimated total of 164 new direct, indirect, and induced jobs of the peak employment year for the proposed project would result in a total population increase of 397 persons, based on average household size in Wyoming of 2.42 in 2006 (per U.S. census estimates) and assuming that all of the jobs are filled with persons not already living in Wyoming.

Although the IMPLAN analysis study area was for the entire state of Wyoming, for purposes of analyzing the impacts to schools and other public services, all 164 jobs were projected to result in population increases to Converse and Natrona Counties. This

overestimates the likely potential for impacts to these two counties because some of the indirect and induced jobs will be located outside of these two counties and some of the jobs in Converse and Natrona Counties will be filled with local residents. The addition of 397 persons would be an increase of less than half of one percent to the total combined 2007 estimated population of 84,618 for Converse and Natrona Counties.

Children between the ages of five and 19 constituted approximately 20 percent of total estimated population in Converse and Natrona Counties in 2007. Using 20 percent as the ratio for school age children, there would be approximately 79 school age children anticipated from the projected increase in total direct, indirect, and induced employment.

Converse School District No.1 in Douglas was adding new facilities in 2008 and 2009 and was anticipating it could handle 350 additional students in grades K-5 and 250 additional students in Middle and High School. Converse School District No. 2 in Glenrock was under capacity in 2008 and would be able to increase enrollment by another 200 students without additional expansion (other than what has already been planned or recently completed). The Natrona County School District (primarily in the Casper area) has approximately 11,500 students.

A total increase of less than half of one percent to the total population of Converse and Natrona County is not likely to create a significant impact on other public services such as fire, police, water, and utilities.

9.4.1.3 Impacts on Noise and Congestion

The existing ambient noise in the vicinity of the proposed project area is dominated by the traffic noise from State Highways 95 and 93.There are a total of 67 residential sites within the two-mile buffer area. There a small cluster of occupied housing units and one operating ranch in the vicinity of the proposed project. The nearest resident is approximately 0.5 miles to the north. The Leuenberger Ranch lies within the proposed project area. The proposed Leuenberger Satellite facility is approximately 2,000 feet from the property boundary of a small rural residential subdivision. Assuming that the noise level produced by unshielded machinery at the plant site is 85dB at 50 feet, the sound pressure level attained at the property boundary will be well below the level identified by the USEPA as suitable for outdoor areas where human activity takes place (approximately 55 dB). After appropriate engineered controls (i.e. the protective enclosure for the equipment) are installed, noise levels will not impact the residences, and are unlikely to approach the levels attained by State Highway 95.

As a result of the remote location of the proposed project area and the low population density of the surrounding area, impact to noise or congestion above ambient background noise within the project area or in the surrounding 2.0-mile area are not anticipated.

Additionally, given the maximum increase in population due to migrant workers is insignificant, noise and congestion impacts are not anticipated in Glenrock, Douglas, Casper, or other neighboring counties.

There will be an increase in traffic from workers to/from the site and also equipment and machinery, and truck traffic in transporting resin to and from the offsite Central Processing Plant. Traffic congestion is not anticipated to be a significant issue, because existing traffic is low (Average Daily Traffic on Highway 95 near Rolling Hills was 1810 in 2006, and Average Daily Traffic on Highway 93 near Orpha was 340 in 2006) and site activities will not increase that traffic volume significantly.

There may also be an insignificant increase in noise levels from associated traffic.

9.4.2 Long Term External Costs

9.4.2.1 Impairment of Recreational and Aesthetic Values

While opportunities for developed and dispersed recreation exist in the 50-mile area surrounding the proposed project, the closest public recreation site is the Bixby Access site (Wyoming Fish and Game) on the North Platte River. The next closest is the Fort Fetterman Historical site, approximately four miles from the proposed project.

9.4.2.2 Land Disturbance

The proposed project area has been used for grazing and some oil and gas development. As the proposed project would use ISR methods, there would be limited land surface disturbance compared to conventional surface mining techniques. Land surface disturbance associated with wellfield development would also be short term as interim stabilization with native vegetation species is implemented as soon as construction activities are complete and maintained through the life of the wellfields. No tailings or waste rock would be generated. Satellite facilities and private access roads would be confined to delineated areas.

9.4.2.3 Habitat Disturbance

Currently, there is no federally or state designated wildlife habitat identified within the proposed project area. As the proposed project area has been historically used extensively for livestock grazing, there are no anticipated long-term losses to wildlife or wildlife habitat relative to the existing conditions resulting from the construction and operation of the proposed project.

9.4.3 Groundwater Impacts

It is unlikely that any future irrigation development would occur within the proposed Project area due to limited water supplies, topography, soils, and climate. Irrigation within the two-mile review area is anticipated to be consistent with the past. Based on population projections, future water use within the two-mile review area would likely be a continuation of present use. Since ISR production is a theoretically closed hydraulic system, except for the one percent bleed, and considering that local water sources are derived from aquifers located above the Production Zone (see Section 7.2.5.2) the surrounding groundwater should not be affected. Therefore, it is anticipated that there would be no significant changes from the existing conditions for public water supply in the project area and within the two mile buffer zone surrounding the proposed project area.

Minimal effects to the existing aquifer as a result of drawdown are anticipated. Following standard mining practice, any contaminated water drawn from the aquifer on site would either be treated before re-injection or disposed through deep well injection. Upon decommissioning, the affected groundwater would be restored and all wells would be plugged and abandoned. The primary goal of the groundwater restoration program would be to return groundwater affected by mining operations to baseline values on a mine unit average. The secondary goal would be to return the groundwater to a quality consistent with pre-mining use. Prior to mining in each mining unit, baseline groundwater quality would be determined. This data would be established for each mine unit at the minimum density of one production or injection well per four acres. Upon completion of restoration, a groundwater stabilization monitoring program would begin in which the restoration wells and any monitor wells on excursion status during mining operations would be sampled and analyzed for the restoration parameters.

Given the historically limited irrigation, the limited domestic groundwater use, and the groundwater restoration program associated with the proposed project, there would be no permanent commitment of water resources required and any potential long-term changes from the No Action groundwater conditions would be limited to those identified and addressed in the groundwater restoration program.

9.4.4 Radiological Impacts

As the proposed project would be using ISR techniques, most of the identified radioactivity in the ore body would remain permanently underground. Following standard ISR procedures, routine operational monitoring of air, surface water and groundwater, and soil would be undertaken by Uranium One as discussed in Section 5. Prior to process plant decommissioning, a preliminary radiological survey would be conducted to identify any potential radiological hazards. The survey will also support the development of

procedures for dealing with such hazards prior to commencement of decommissioning activities.

Decommissioning of process facilities would start only after NRC approval of a Decommissioning Plan in accordance with the most current applicable NRC rules and regulations, permit and license stipulations and amendments in effect at the time of the decommissioning activity.

All process or potentially contaminated equipment and materials at the facility including; tanks, filters, pumps, piping, etc., would be designated for one of the following removal alternatives:

- Removal to a new location within the proposed project area for further use or storage;
- Removal to another NRC licensed facility for either use or permanent disposal; or
- Decontamination to meet unrestricted use criteria for release.

It is likely that process buildings would be dismantled and moved to another location or to a permanent licensed disposal facility. Cement foundation pads and footings would be broken up and trucked to a disposal site or to a licensed facility if contaminated. The landowners may request that a building or other structures be left on site for future use. In that case, the building would be decontaminated to meet unrestricted use criteria.

Under the proposed operating and decommissioning conditions, the potential long-term radiological impacts at the project are anticipated to be negligible compared to the existing background no action conditions.

9.5 BENEFIT-COST SUMMARY

A primary economic benefit of the project is the creation of 164 new permanent and part time jobs at peak employment within the county and surrounding areas, including the direct, indirect and induced employment effects over the construction and operating life of the project (Table 9-3). Additionally, the project may generate up to $20 million in total state and local business tax revenues over the life of the project, which is a significant economic gain compared to the no action alternative.

Table 9-3 further shows that the short-terms effects on housing, schools and public facilities and the increased potential for noise and congestion in the county involve little or no change compared to the current conditions. Based on the historical land uses, physical remoteness and proposed reclamation practices, no potential quantifiable long-term impairments appear to significantly offset the benefits of the proposed project.

The proposed project is likely to place negligible short-term or long-term cost burdens on the Converse and Natrona Counties, while providing increased revenue and employment opportunities; therefore, the development and operation of the proposed project would provide a net economic benefit to Converse and Natrona Counties when compared to the no action alternative.

Table 9-3 Summary of Benefits and Costs for the Proposed Project

Benefits	Costs
• **Tax revenue** $20. million • **Temporary and permanent jobs** 164 jobs at peak employment	• **Housing impacts** Little or no change • **Schools and Public Facilities** Negligible • **Noise and Congestion** None • **Impairment of recreational and Aesthetic values** Negligible • **Land Disturbance** Minor • **Groundwater impacts** Controlled through mitigation • **Radiological Impacts** Controlled through mitigation

Figure 9-1: Proposed Project Schedule for Construction, Operations, and Decommissioning.

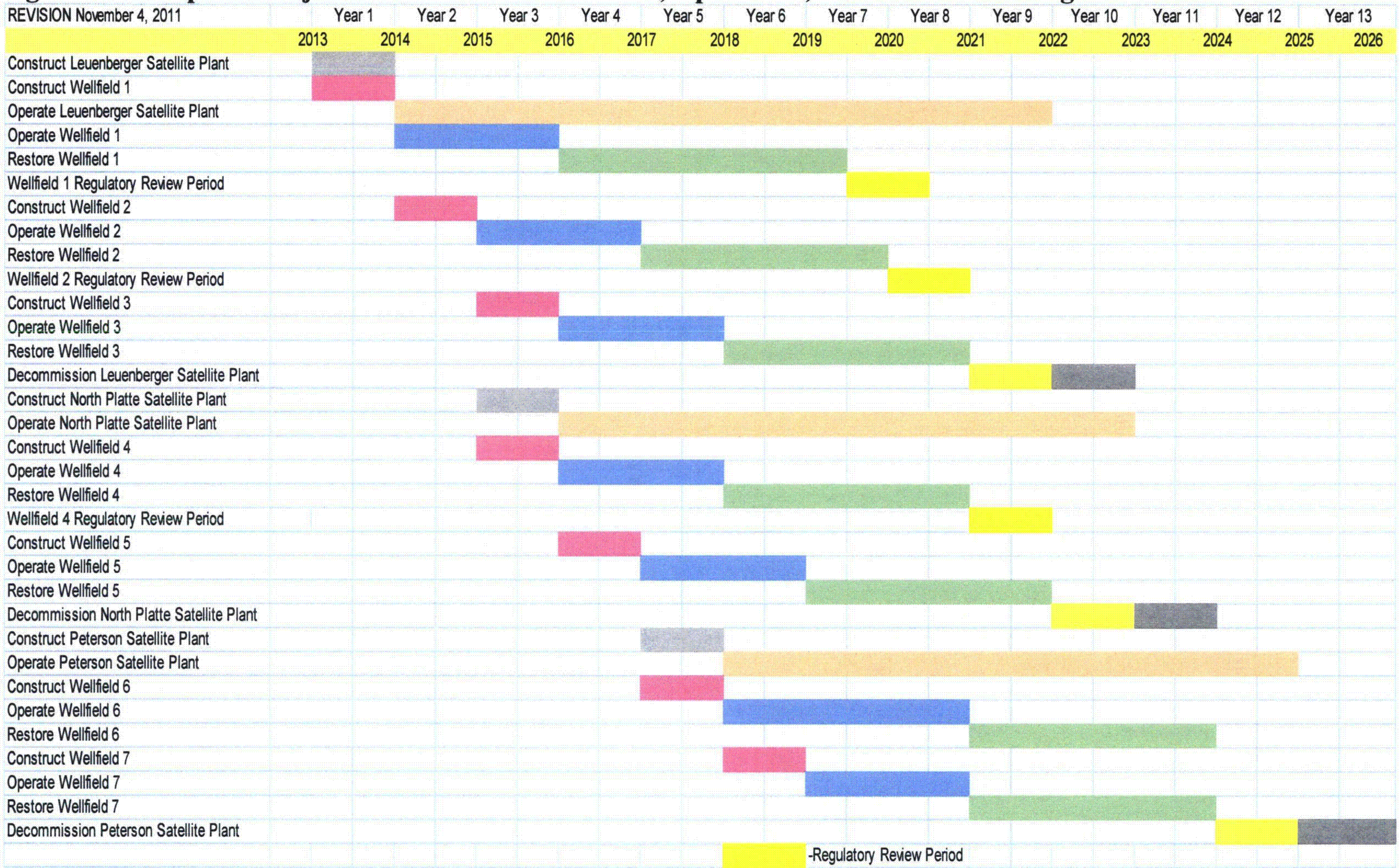

Figure 9-2: Estimated Non-Payroll Costs of Construction, Operations, and Decommissioning by Year (in constant 2009 $)

REVISION November 4, 2011	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025 2026
Construct Leuenberger Satellite Plant	6,983,871												
Construct Wellfield 1	10,498,233												
Operate Leuenberger Satellite Plant		1,240,039	1,240,039	1,240,039	1,240,039	1,240,039	1,240,039	1,240,039	1,240,039				
Operate Wellfield 1		417,232	417,232										
Restore Wellfield 1													
Wellfield 1 Regulatory Review Period													
Construct Wellfield 2		9,783,336											
Operate Wellfield 2			417,232	417,232									
Restore Wellfield 2													
Wellfield 2 Regulatory Review Period													
Construct Wellfield 3			10,498,233										
Operate Wellfield 3				417,232	417,232								
Restore Wellfield 3													
Decommission Leuenberger Satellite Plant										6,308,491			
Construct North Platte Satellite Plant			6,983,871										
Operate North Platte Satellite Plant				1,240,039	1,240,039	1,240,039	1,240,039	1,240,039	1,240,039	1,240,039			
Construct Wellfield 4			9,783,336										
Operate Wellfield 4				417,232	417,232								
Restore Wellfield 4													
Wellfield 4 Regulatory Review Period													
Construct Wellfield 5				10,498,233									
Operate Wellfield 5					417,232	417,232							
Restore Wellfield 5													
Decommission North Platte Satellite Plant											6,308,491		
Construct Peterson Satellite Plant					6,983,871								
Operate Peterson Satellite Plant						1,240,039	1,240,039	1,240,039	1,240,039	1,240,039	1,240,039	1,240,039	
Construct Wellfield 6					9,783,336								
Operate Wellfield 6						417,232	417,232	417,232					
Restore Wellfield 6													
Construct Wellfield 7						10,498,233							
Operate Wellfield 7							417,232	417,232					
Restore Wellfield 7													
Decommission Peterson Satellite Plant													6,308,491
Subtotal - Construction-Non Payroll	17,482,104	9,783,336	27,265,440	11,749,929	16,767,207	10,498,233	0	0	0	6,308,491	6,308,491	0	6,308,491
Subtotal - Oprerations-Non Payroll		1,657,271	2,074,503	3,731,774	3,731,774	4,554,581	4,554,581	4,554,581	3,720,117	2,480,078	1,240,039	1,240,039	0
Total - Non Payroll	17,482,104	11,440,607	29,339,943	15,481,703	20,498,981	15,052,814	4,554,581	4,554,581	3,720,117	8,788,569	7,548,530	1,240,039	6,308,491

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Figure 9-3: Estimated Payroll Costs of Construction and Decommissioning by Year (Direct Payroll of Proposed Project in Constant 2009 $).

2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026

REVISION November 4, 2011	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Construct Leuenberger Satellite Plant													
Construct Wellfield 1	802,575												
Operate Leuenberger Satellite Plant													
Operate Wellfield 1													
Restore Wellfield 1													
Wellfield 1 Regulatory Review Period													
Construct Wellfield 2		802,575											
Operate Wellfield 2													
Restore Wellfield 2													
Wellfield 2 Regulatory Review Period													
Construct Wellfield 3			802,575										
Operate Wellfield 3													
Restore Wellfield 3													
Decommission Leuenberger Satellite Plant										603,450			
Construct North Platte Satellite Plant													
Operate North Platte Satellite Plant													
Construct Wellfield 4			802,575										
Operate Wellfield 4													
Restore Wellfield 4													
Wellfield 4 Regulatory Review Period													
Construct Wellfield 5				802,575									
Operate Wellfield 5													
Restore Wellfield 5													
Decommission North Platte Satellite Plant											603,450		
Construct Peterson Satellite Plant													
Operate Peterson Satellite Plant													
Construct Wellfield 6					802,575								
Operate Wellfield 6													
Restore Wellfield 6													
Construct Wellfield 7						802,575							
Operate Wellfield 7													
Restore Wellfield 7													
Decommission Peterson Satellite Plant													603,450
Subtotal - Construction-Non Payroll	802,575	802,575	1,605,150	802,575	802,575	802,575	0	0	0	603,450	603,450	0	603,450
Subtotal - Operations-Non Payroll		0	0	0	0	0	0	0	0	0	0	0	0
Total - Non Payroll	802,575	802,575	1,605,150	802,575	802,575	802,575	0	0	0	603,450	603,450	0	603,450

Figure 9-4: Estimated Number of Payroll Positions for Construction, Operations, and Decommission (Direct payroll of the Proposed Project)

2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026

REVISION November 4, 2011	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Construct Leuenberger Satellite Plant	0												
Construct Wellfield 1	7												
Operate Leuenberger Satellite Plant		10	10	10	10	10	10	10	1				
Operate Wellfield 1		3.5	3.5										
Restore Wellfield 1				0	0	0							
Wellfield 1 Regulatory Review Period													
Construct Wellfield 2		7											
Operate Wellfield 2			3.5	3.5									
Restore Wellfield 2					3.5	3.5	3.5						
Wellfield 2 Regulatory Review Period													
Construct Wellfield 3			7										
Operate Wellfield 3				3.5	3.5								
Restore Wellfield 3						3.5	3.5	3.5					
Decommission Leuenberger Satellite Plant										10			
Construct North Platte Satellite Plant			0										
Operate North Platte Satellite Plant				10	10	10	10	10	10	1			
Construct Wellfield 4			7										
Operate Wellfield 4				3.5	3.5								
Restore Wellfield 4						3.5	3.5	3.5					
Wellfield 4 Regulatory Review Period													
Construct Wellfield 5				7									
Operate Wellfield 5					3.5	3.5							
Restore Wellfield 5							3.5	3.5	3.5				
Decommission North Platte Satellite Plant											10		
Construct Peterson Satellite Plant					0								
Operate Peterson Satellite Plant						10	10	10	10	10	10	1	
Construct Wellfield 6					7								
Operate Wellfield 6						3.5	3.5	3.5					
Restore Wellfield 6									3.5	3.5	3.5		
Construct Wellfield 7						7							
Operate Wellfield 7							3.5	3.5					
Restore Wellfield 7									3.5	3.5	3.5		
Decommission Peterson Satellite Plant													10
Subtotal - Construction-Non Payroll	7.0	7.0	14.0	17.5	7.0	7.0	0.0	0.0	0.0	10.0	10.0	0.0	10.0
Subtotal - Oprerations-Non Payroll	0.0	13.5	17.0	30.5	34.0	47.5	51.0	47.5	31.5	7.0	17.0	1.0	0.0
Total - Non Payroll	7.0	20.5	31.0	48.0	41.0	54.5	51.0	47.5	31.5	17.0	27.0	1.0	10.0

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10 ENVIRONMENTAL APPROVALS AND CONSULTATIONS

Various permits and approvals from numerous Federal and State agencies will be required for the proposed Ludeman Project (proposed project) to operate. This section identifies the issuing agencies, a description of the type of permit(s), license, or approvals needed, and the current status of securing these approvals.

10.1 APPLICABLE REGULATORY REQUIREMENTS, PERMITS, AND REQUIRED CONSULTATIONS

Table 10-1 lists the necessary environmental approvals from Federal and State Agencies required for the proposed project. The NRC licensing process for amendment of the Source Materials License represents the longest lead-time approval; therefore, the majority of the remaining approvals are in progress or will be initiated within the next year. All necessary approvals must be secured prior to commencement of commercial production at the site.

Table 10-1: Summary of Proposed, Pending and Approved Permits for the Proposed Project

Issuing Agency	Description	Status
Wyoming Department of Environmental Quality 122 West 25th St Herschler Building Cheyenne, Wyoming 82001	Underground Injection Control Class III Permit (WDEQ Title 35-11)	Permit to Mine Application – submitted February 10, 2010, Application was deemed complete on August 12, 2011, currently under technical review by WDEQ-LQD.
	Groundwater Reclassification (EPA-Aquifer Exemption) (WDEQ Title 35-11)	Groundwater reclassification will be completed (information in application) by WDEQ prior to issuance of final Permit, and confer with EPA's on their Aquifer Exemption process.
	Underground Injection Control Permit (Deep Disposal Well) (WDEQ Title 35-11)	Class I UIC Permit application under preparation; expected submittal to WDEQ in Q3 - 2012.
	Industrial Stormwater NPDES Permit (WDEQ Title 35-11)	An Industrial State Stormwater WPDES Permit will be required for the satellite facilities. Expected application submittal 30 days prior to start of operations.

Issuing Agency	Description	Status
	Construction Stormwater NPDES Permit (WDEQ Title 35-11)	Construction Stormwater NPDES authorizations are applied for and issued annually under a general permit based on projected construction activities. The Notice of Intent will be filed at least 30 days before construction activities begin in accordance with WDEQ requirements. (Q2 -2013)
	Mineral Exploration Permit (WDEQ Title 35-11)	Approved Mineral Exploration Permit 339DN is currently in place for the Ludeman area.
	Underground Injection Control Class V, Septic System (WDEQ Title 35-11)	The Class V UIC permit will be applied for following installation of an approved site septic system during facility construction.
	Air Quality Permit	Application will be submitted six months prior to start of construction (Q1 2013)
U.S. Nuclear Regulatory Commission Washington, DC 20555	Amendment of Materials License SUA-1341 (10 CFR 40)	Application submitted herein
U.S. Environmental Protection Agency 1200 Pennsylvania Ave, NW, Washington, DC 20460	Aquifer Exemption (40 CFR 144, 146)	See Groundwater reclassification process above
U.S. Department of Interior, Bureau of Land Management 2987 Prospector Drive Casper, WY 826040	Notice of Intent to Explore (43 CFR 3809)	Notice of Intent to Explore will be submitted as needed for exploration drilling activities on BLM surface
U.S. Army Corps of Engineers 2232 Dell Range BLVD., Suite 210 Cheyenne, WY 82009-4942	Nationwide Permit Authorization, Wetlands	All necessary information has been provided to the USACE, USACE has determined (May 11, 2011) the methods used to identify wetlands within the permit are consistent with the Corps of Engineers Wetland Delineation Manual. Activities can be covered under nationwide permits.

10.2 ENVIRONMENTAL CONSULTATION

During the course of the preparation of this license application, consultations were conducted with several agencies:

Ecological Resources

Preparation of the ecological resources discussion (Section 2.8) required consultations with the following individuals and agencies:

Wetlands

Mathew A. Bilodeau
Paige Wolken
United States Army Corps of Engineers
2232 Dell Range Blvd, Suite 210
Cheyenne, WY 82009-4942

Soils

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Douglas NRCS
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Lowell Spackman and Anna Waitkus
Wyoming Department of Environmental Quality-Land Quality Division
Herschler Building
122 W 25th St.
Cheyenne, WY 82002

Wildlife

Shane Gray
Wildlife Biologist
Bureau of Land Management
2987 Prospector Dr.
Casper, WY 82604